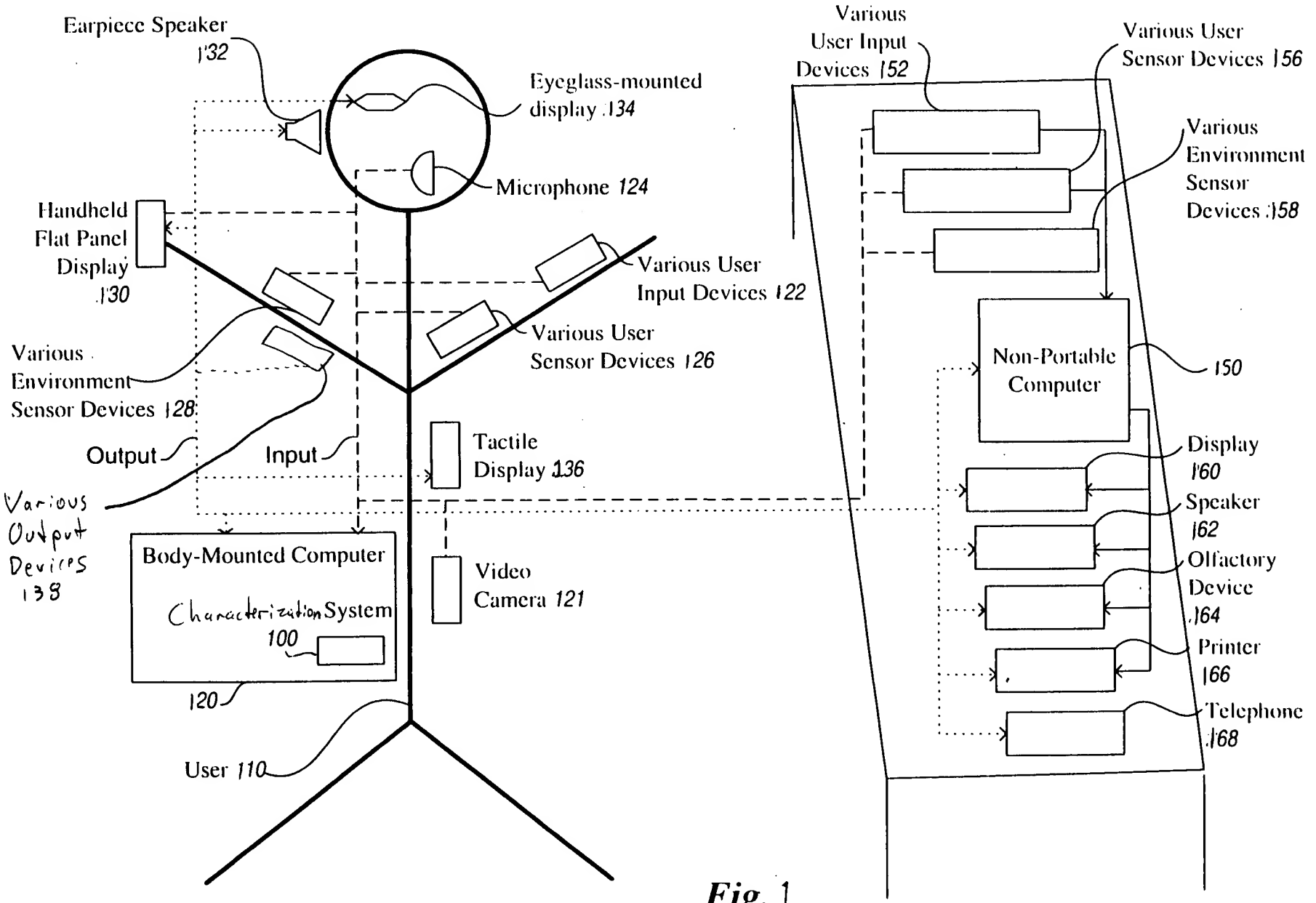

Earpiece Speaker 132
Eyeglass-mounted display 134
Microphone 124
Handheld Flat Panel Display 130
Various User Input Devices 122
Various User Sensor Devices 126
Various Environment Sensor Devices 128
Output
Input
Various Output Devices 138
Tactile Display 136
Body-Mounted Computer
Characterization System 100
120
Video Camera 121
User 110
Various User Input Devices 152
Various User Sensor Devices 156
Various Environment Sensor Devices 158
Non-Portable Computer 150
Display 160
Speaker 162
Olfactory Device 164
Printer 166
Telephone 168

*Fig. 1*

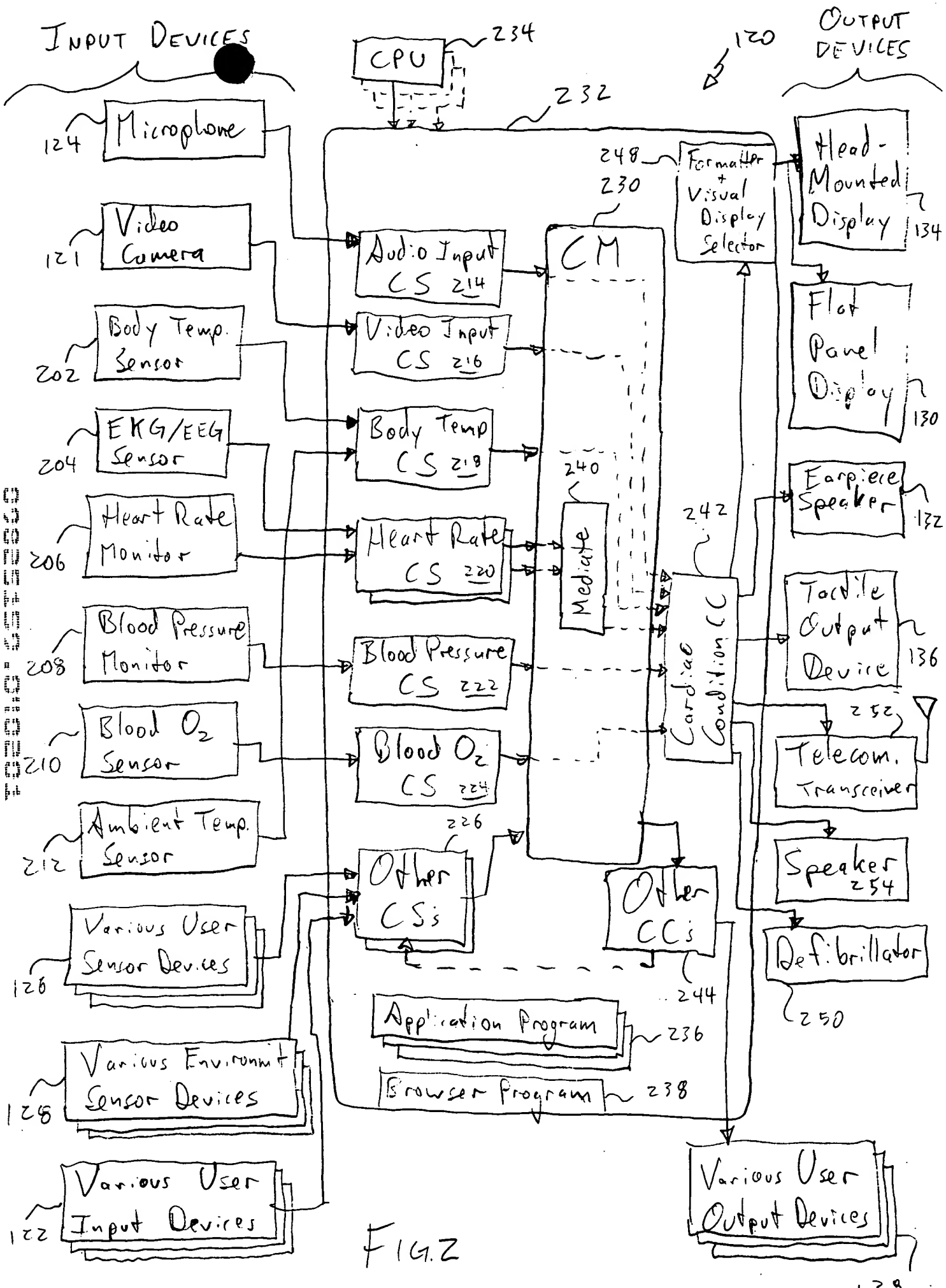

INPUT DEVICES
OUTPUT DEVICES
120
CPU
234
232
124
Microphone
121
Video Camera
202
Body Temp. Sensor
204
EKG/EEG Sensor
206
Heart Rate Monitor
208
Blood Pressure Monitor
210
Blood O2 Sensor
212
Ambient Temp. Sensor
126
Various User Sensor Devices
128
Various Environmt Sensor Devices
122
Various User Input Devices
Audio Input CS 214
Video Input CS 216
Body Temp CS 218
Heart Rate CS 220
Blood Pressure CS 222
Blood O2 CS 224
226
Other CSs
230
CM
240
Mediate
242
Cardiac Condition CC
Other CCs
244
Application Program
236
Browser Program
238
248
Formatter + Visual Display Selector
Head-Mounted Display
134
Flat Panel Display
130
Earpiece Speaker
132
Tactile Output Device
136
252
Telecom. Transceiver
Speaker
254
Defibrillator
250
Various User Output Devices
138

FIG. 2

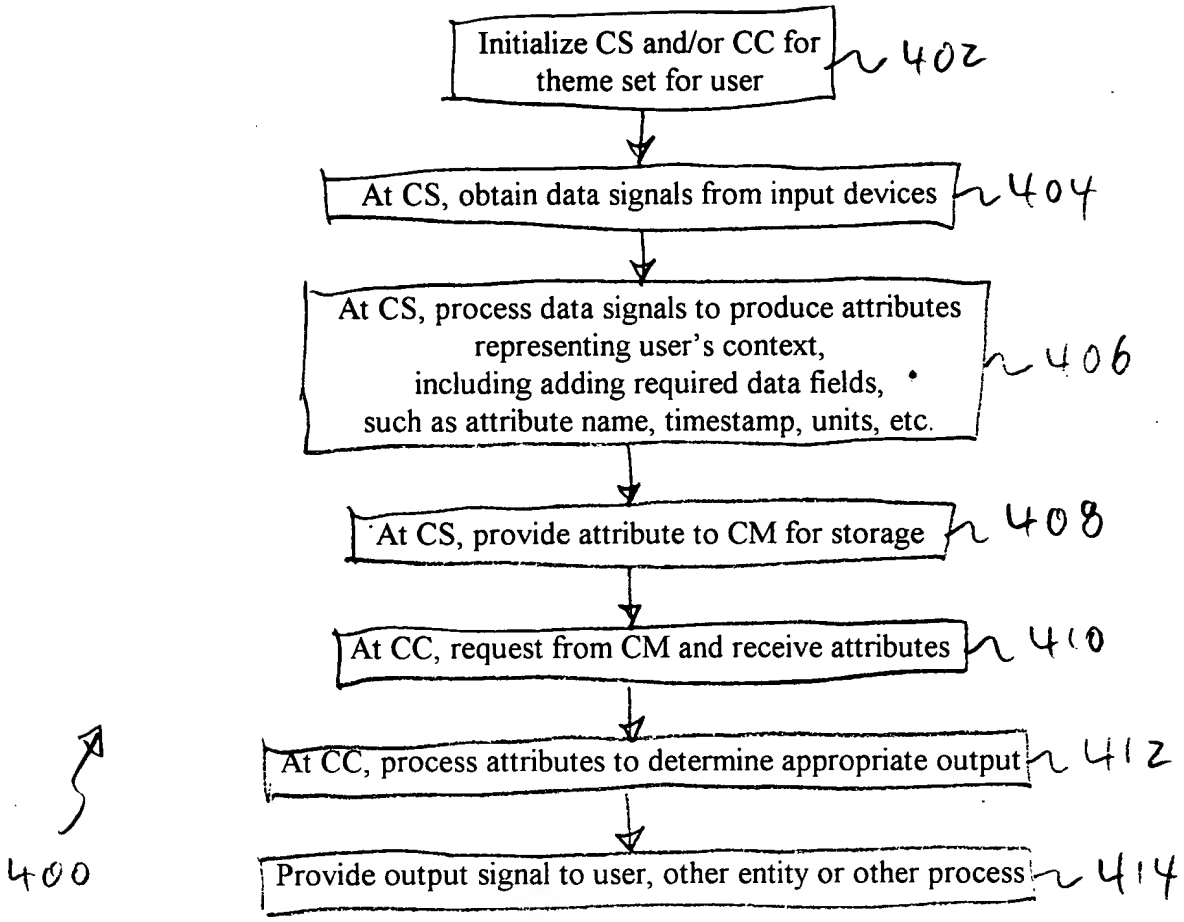

Initialize CS and/or CC for theme set for user
402
At CS, obtain data signals from input devices
404
At CS, process data signals to produce attributes representing user's context, including adding required data fields, such as attribute name, timestamp, units, etc.
406
At CS, provide attribute to CM for storage
408
At CC, request from CM and receive attributes
410
At CC, process attributes to determine appropriate output
412
Provide output signal to user, other entity or other process
414
400

FIG 4

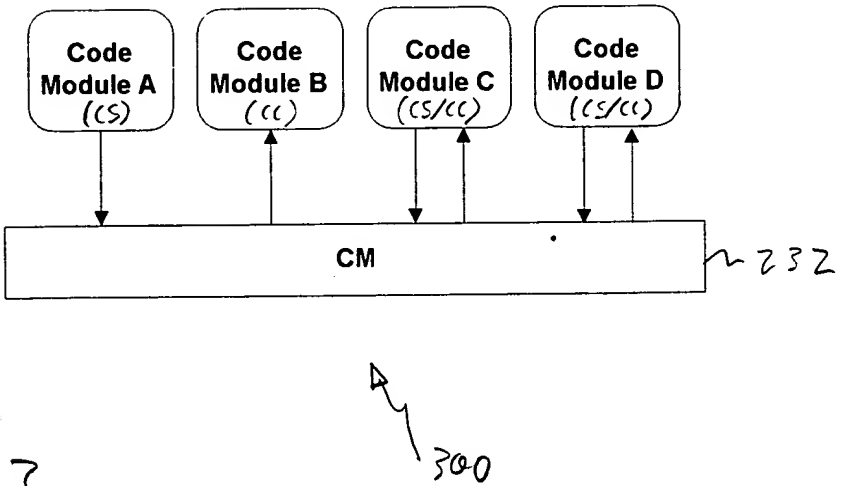

Code Module A (CS)
Code Module B (CC)
Code Module C (CS/CC)
Code Module D (CS/CC)
CM
232
300

FIG 3

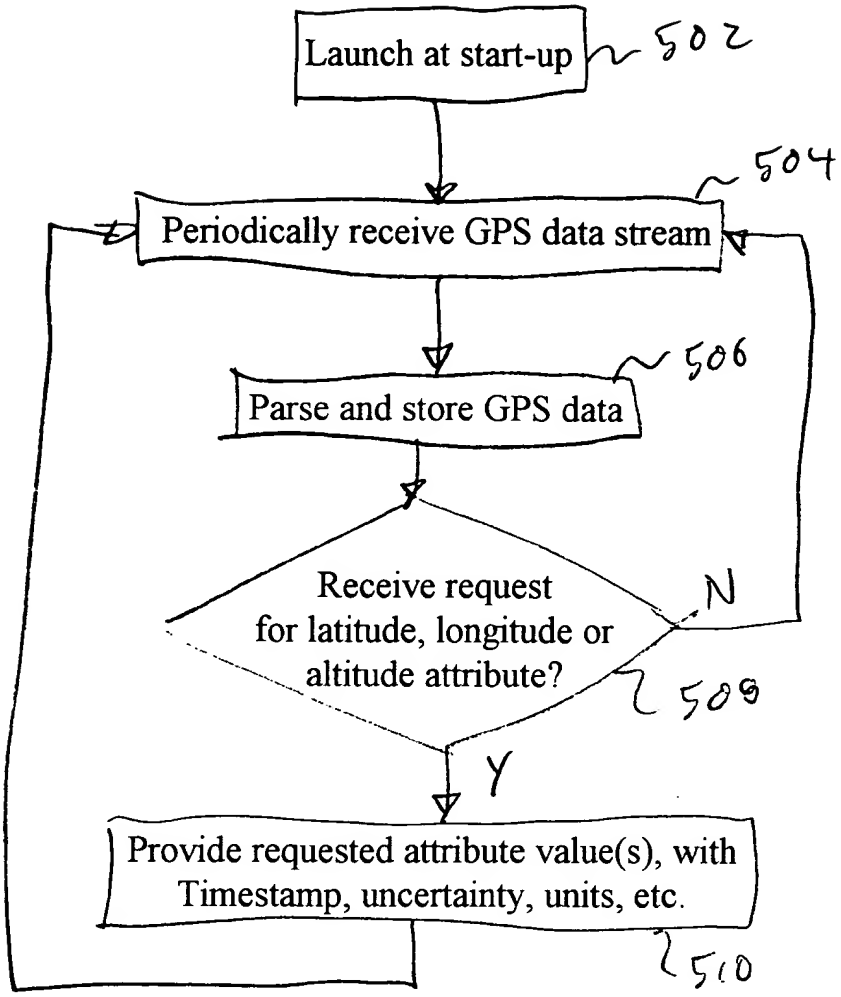

Launch at start-up
502
Periodically receive GPS data stream
504
Parse and store GPS data
506
Receive request for latitude, longitude or altitude attribute?
N
508
Y
Provide requested attribute value(s), with Timestamp, uncertainty, units, etc.
510
500

FIG 5A

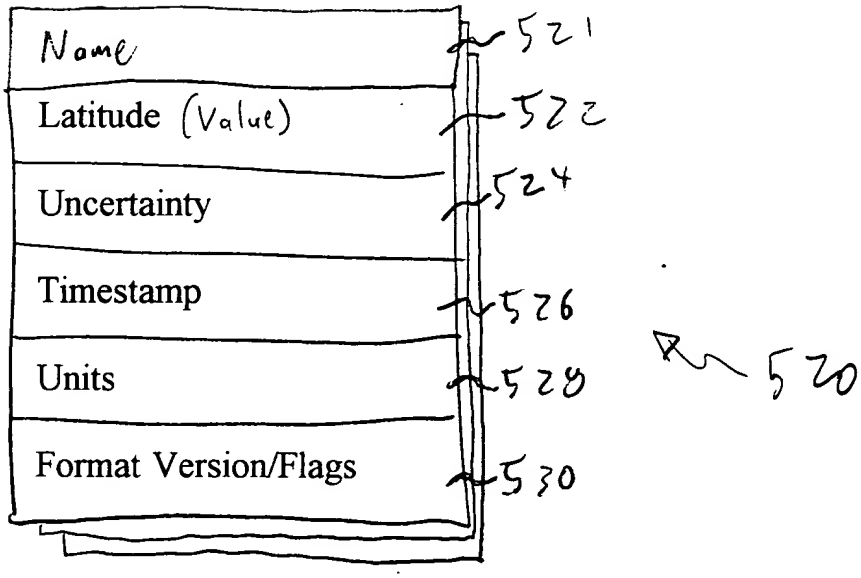

Name
521
Latitude (Value)
522
Uncertainty
524
Timestamp
526
Units
528
Format Version/Flags
530
520

FIG 5B

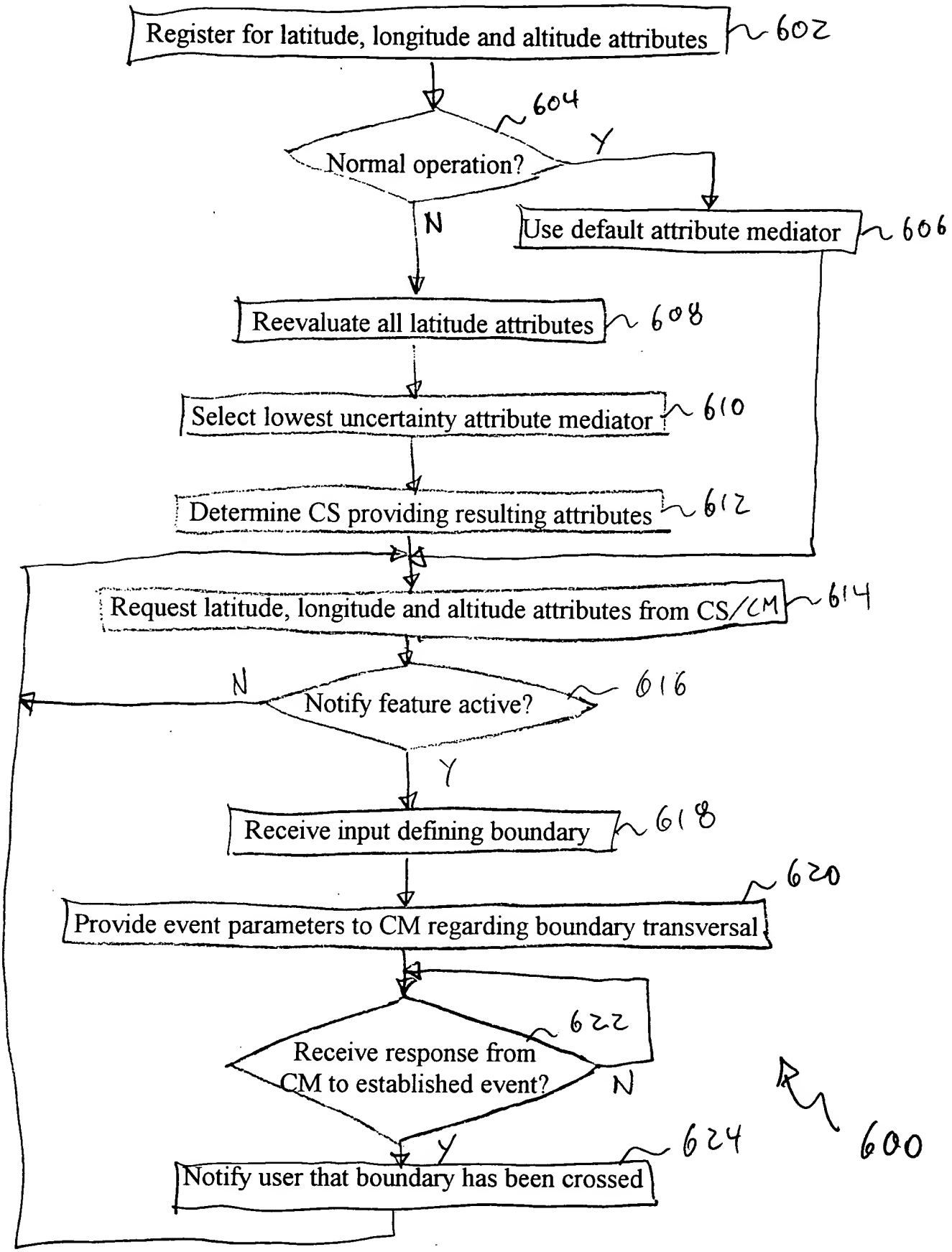

Register for latitude, longitude and altitude attributes
602
604
Normal operation?
Y
N
Use default attribute mediator
606
Reevaluate all latitude attributes
608
Select lowest uncertainty attribute mediator
610
Determine CS providing resulting attributes
612
Request latitude, longitude and altitude attributes from CS/CM
614
N
Notify feature active?
616
Y
Receive input defining boundary
618
620
Provide event parameters to CM regarding boundary transversal
622
Receive response from CM to established event?
N
Y
624
Notify user that boundary has been crossed
600

FIG 6

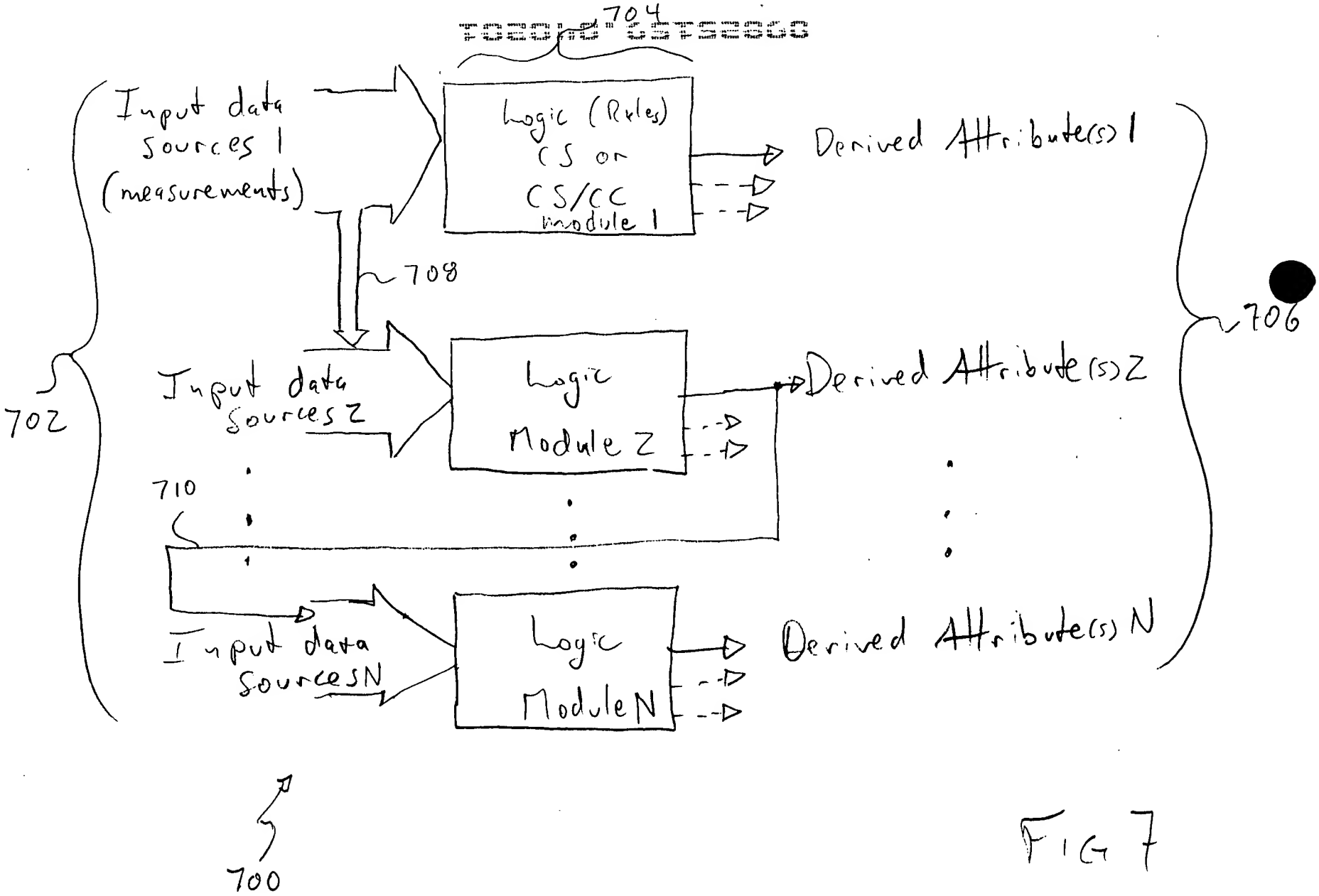

704
Input data sources 1 (measurements)
Logic (Rules) CS or CS/CC module 1
Derived Attribute(s) 1
708
706
702
Input data sources 2
Logic Module 2
Derived Attribute(s) 2
710
Input data sources N
Logic Module N
Derived Attribute(s) N
700

FIG 7

**User.**
- Desired_privacy_level
- Interruptibility
- Speed
- Direction
- Acceleration
- Availability.
  - Cognitive_availability
  - Tactile_availability
  - Manual_availability
  - Visual_availability
  - Oral_availability
  - Auditory_availability
- Proximity.<Item or place name>
- Mood.
  - Happiness
  - Sadness
  - Anger
  - Frustration
  - Confusion
- Activity.
  - Driving
  - Eating
  - Running
  - Sleeping
  - Talking
  - Typing
  - Walking
- Location.
  - Place_name
  - Latitude
  - Longitude
  - Altitude
  - Room
  - Floor
  - Building
  - Address
  - Street
  - City
  - County
  - State
  - Country
  - Postal_Code
- Destination. (same as User.Location.)
- Physiology.
  - Pulse
  - Body_temperature
  - Blood_pressure
  - Respiration

**Person.**<name or ID>. (same as User.)

**Platform.**
- UI.
  - Oral_input_device_availability
  - Manual_input_device_availability
  - Tactile_output_device_availability
  - Visual_output_device_availability
  - Auditory_output_device_availability

**Platform.** (continued)
- CPU.
  - Load
  - Speed
- Memory.
  - Total_capacity
  - Used
- Storage.
  - Total_capacity
  - Used
- Connectivity.
  - Connection_status
  - Connection_speed
  - Connection_type/device
  - Connection_activity
- Power.
  - Power_source
  - Power_level

**Environment.**
- People.
  - Nearest
  - Number_present
  - Number_close
- Local.
  - Time
  - Date
  - Temperature
  - Pressure
  - Wind_speed
  - Wind_direction
  - Absolute_humidity
  - High_forecast_temperature
  - Low_forecast_temperature
  - People_present
  - Ambient_noise_level
  - Ambient_light_level
  - Days.<previous or future>.
    - High_temperature
    - Low_temperature
    - Precipitation_type
    - Precipitation_amount
- Place.<place name>. (same as Environment.Local)

**Application.**
- Mail.
  - Available
  - New_messages_waiting
  - Messages_waiting_to_be_sent
- Phone.
  - Available
  - In_use
  - On/off
  - Notification_mechanism
  - Call_incoming
  - Caller_ID
- Sound_recorder.
  - Available
  - Recording

Fig 8

- **User Setting**
  - Mental Context
    - Meaning
    - Cognition
      - Divided User Attention
      - Task Switching
      - Background Awareness
    - Solitude
    - Privacy
      - Desired Privacy
      - Perceived Privacy
    - Social Context
    - Affect
  - Physical Situation
    - Body
      - Biometrics
      - Posture
      - Motion
      - Physical Encumberment
        - Senses
          - Eyes
          - Ears
          - Tactile
          - Hands
          - Nose
          - Tongue
        - Workload demands/effects
        - Interaction with computer devices
        - Interaction with people
        - Physical Health
    - Environment
      - Time/Space
      - Objects
      - Persons
        - Audience/Privacy Availability
          - Scope of Disclosure
          - Hardware affinity for privacy
          - Privacy Indicator for User
          - Privacy Indicator for Public
          - Watching Indicator
          - Being Observed Indicator
      - Ambient Interference
        - Visual
        - Audio
        - Tactile

- **Computer**
  - Power
  - Configuration
    - User Input Systems
      - Hand/Haptic
        - Keyboard/Keystrokes
      - Voice/Audio
      - Eye Tracking
      - Cursors
        - Axis
        - Resolution
          - Selection
          - Invocation
        - Accelerators
    - Output Systems
      - Visual
        - Resolution
      - Audio
        - Public/Private
      - Haptic
    - External Resources
      - I/O devices
      - Connectivity
  - Data
    - Quantity/State
    - Urgency/Importance
      - Use of Prominence
    - Modality
    - Sensitivity/Purpose
      - Privacy Issues
      - Use of Association
      - Use of Safety
    - Source/Ownership
      - Types
        - User generated
        - Other computers or people
        - Sensor
        - PC State
      - Use of Association

FIG 9

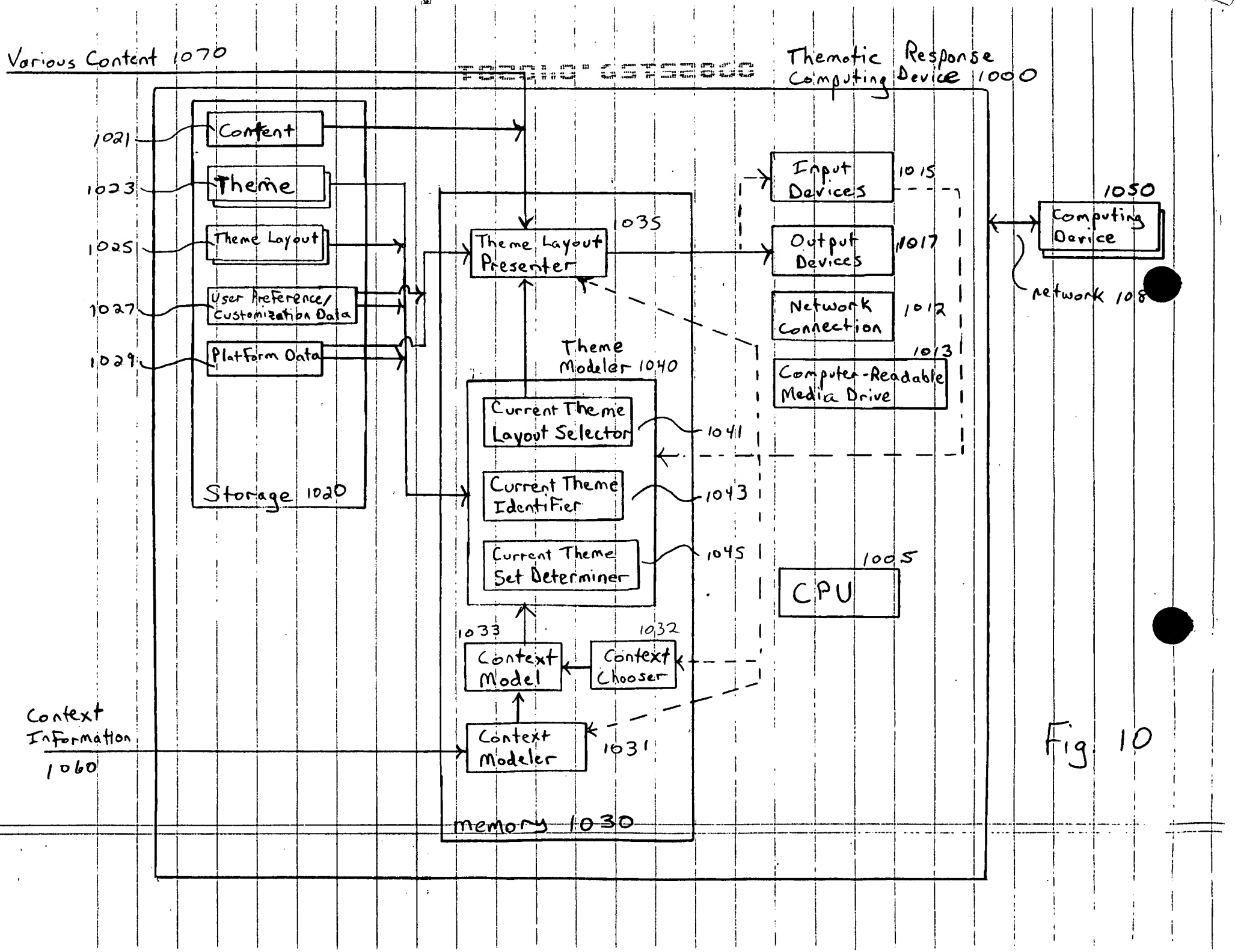

Various Content 1070
Thematic Response Computing Device 1000
1021
Content
1023
Theme
1025
Theme Layout
1027
User Preference/ Customization Data
1029
Platform Data
Storage 1020
Theme Layout Presenter
1035
Input Devices
1015
Output Devices
1017
Network Connection
1012
Computer-Readable Media Drive
1013
1050
Computing Device
network 108
Theme Modeler 1040
Current Theme Layout Selector
1041
Current Theme Identifier
1043
Current Theme Set Determiner
1045
1005
CPU
1033
Context Model
1032
Context Chooser
Context Modeler
1031
Context Information 1060
memory 1030

Fig. 10

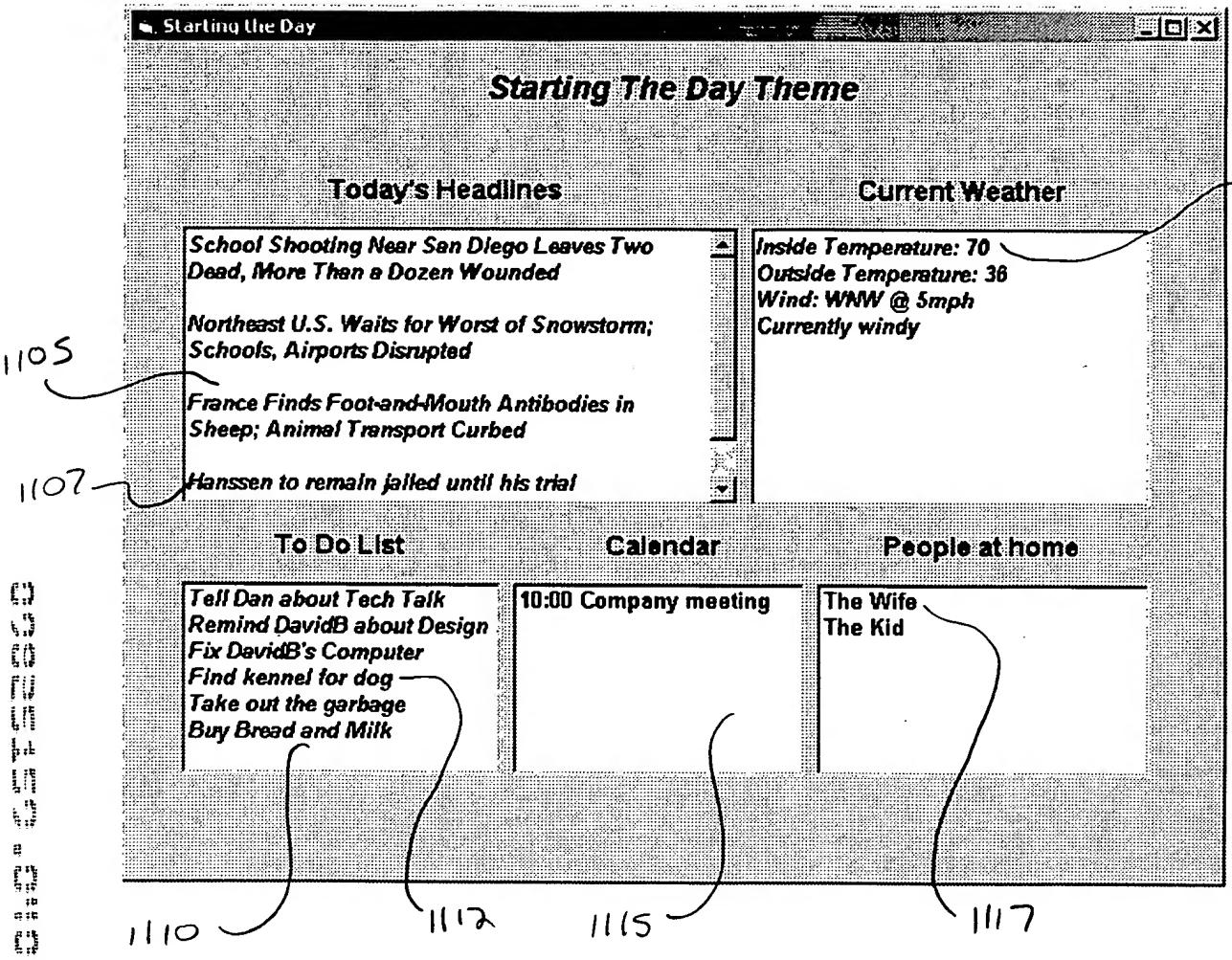

Starting the Day
Starting The Day Theme
Today's Headlines
Current Weather
School Shooting Near San Diego Leaves Two Dead, More Than a Dozen Wounded
Northeast U.S. Waits for Worst of Snowstorm; Schools, Airports Disrupted
France Finds Foot-and-Mouth Antibodies in Sheep; Animal Transport Curbed
Hanssen to remain jailed until his trial
Inside Temperature: 70
Outside Temperature: 36
Wind: WNW @ 5mph
Currently windy
To Do List
Calendar
People at home
Tell Dan about Tech Talk
Remind DavidB about Design
Fix DavidB's Computer
Find kennel for dog
Take out the garbage
Buy Bread and Milk
10:00 Company meeting
The Wife
The Kid
1105
1107
1109
1110
1112
1115
1117

Fig. 11A

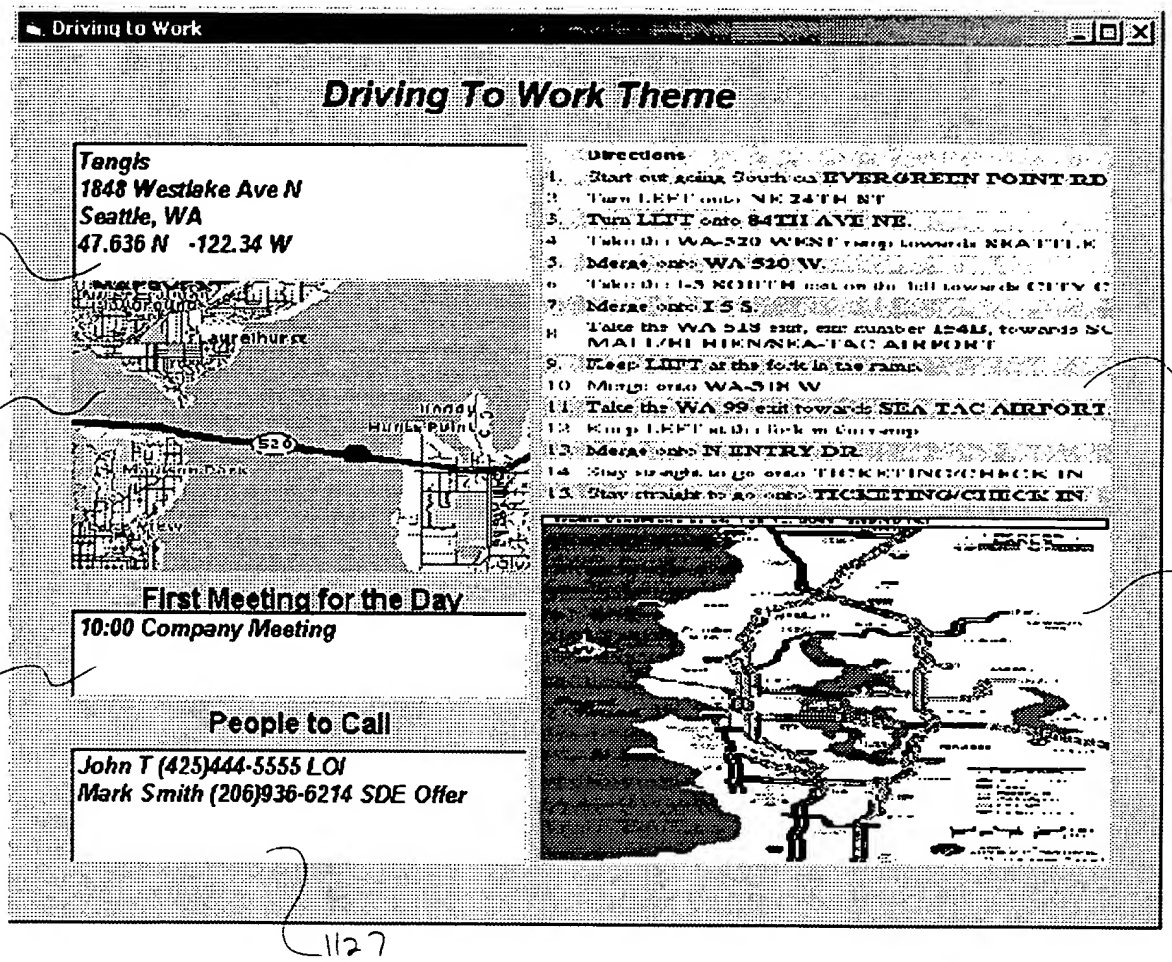

Driving to Work
Driving To Work Theme
Tengis
1848 Westlake Ave N
Seattle, WA
47.636 N -122.34 W
1120
1121
First Meeting for the Day
10:00 Company Meeting
People to Call
John T (425)444-5555 LOI
Mark Smith (206)936-6214 SDE Offer
1127
Directions
1. Start out going South on EVERGREEN POINT RD
3. Turn LEFT onto NE 24TH ST
5. Turn LEFT onto 84TH AVE NE
4. Take the WA-520 WEST ramp towards SEATTLE
5. Merge onto WA-520 W.
7. Merge onto I-5 S.
8. Take the WA-518 exit, exit number 154B, towards SEA-TAC AIRPORT
9. Keep LEFT at the fork in the ramp
10. Merge onto WA-518 W
11. Take the WA-99 exit towards SEA TAC AIRPORT
12. Keep LEFT at the fork in the ramp
13. Merge onto N ENTRY DR
14. Stay straight to go onto TICKETING/CHECK IN
15. Stay straight to go onto TICKETING/CHECK IN
1122
1123
1125

Fig. 11B

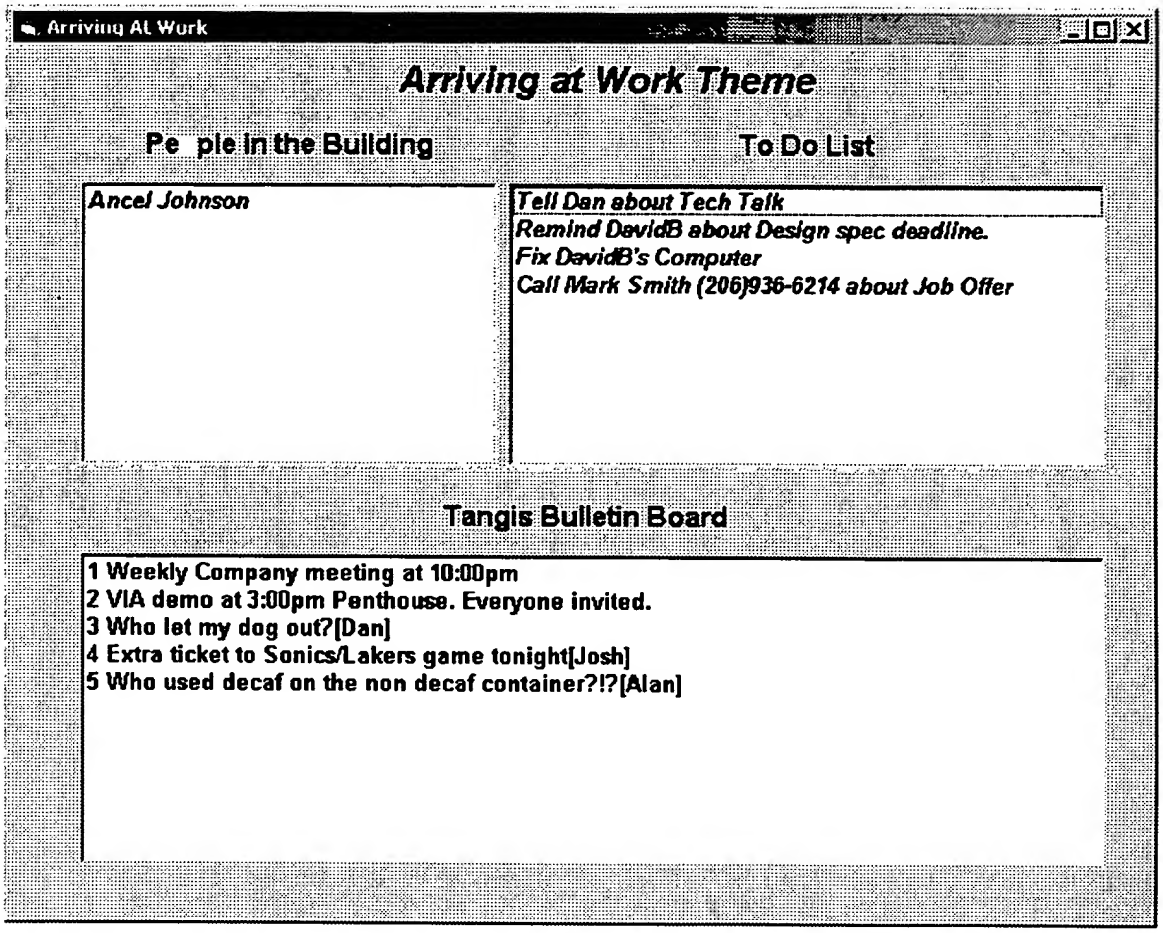

Arriving At Work
Arriving at Work Theme
Pe ple in the Building
To Do List
Ancel Johnson
Tell Dan about Tech Talk
Remind DavidB about Design spec deadline.
Fix DavidB's Computer
Call Mark Smith (206)936-6214 about Job Offer
Tangis Bulletin Board
1 Weekly Company meeting at 10:00pm
2 VIA demo at 3:00pm Penthouse. Everyone invited.
3 Who let my dog out?[Dan]
4 Extra ticket to Sonics/Lakers game tonight[Josh]
5 Who used decaf on the non decaf container?!?[Alan]

Fig. 11C

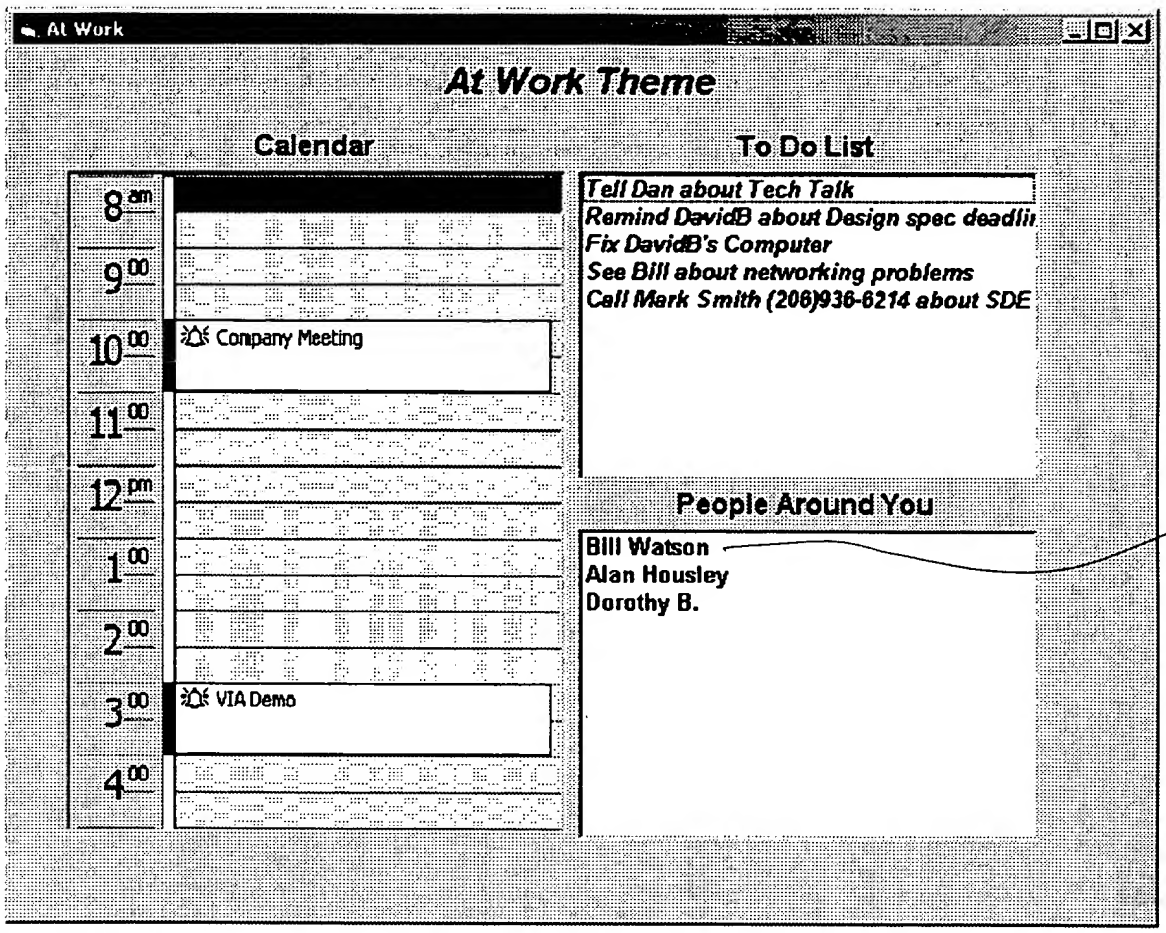

At Work
At Work Theme
Calendar
To Do List
8 am
9 00
10 00
11 00
12 pm
1 00
2 00
3 00
4 00
Company Meeting
VIA Demo
Tell Dan about Tech Talk
Remind DavidB about Design spec deadli
Fix DavidB's Computer
See Bill about networking problems
Call Mark Smith (206)936-6214 about SDE
People Around You
Bill Watson
Alan Housley
Dorothy B.
1130

Fig. 11D

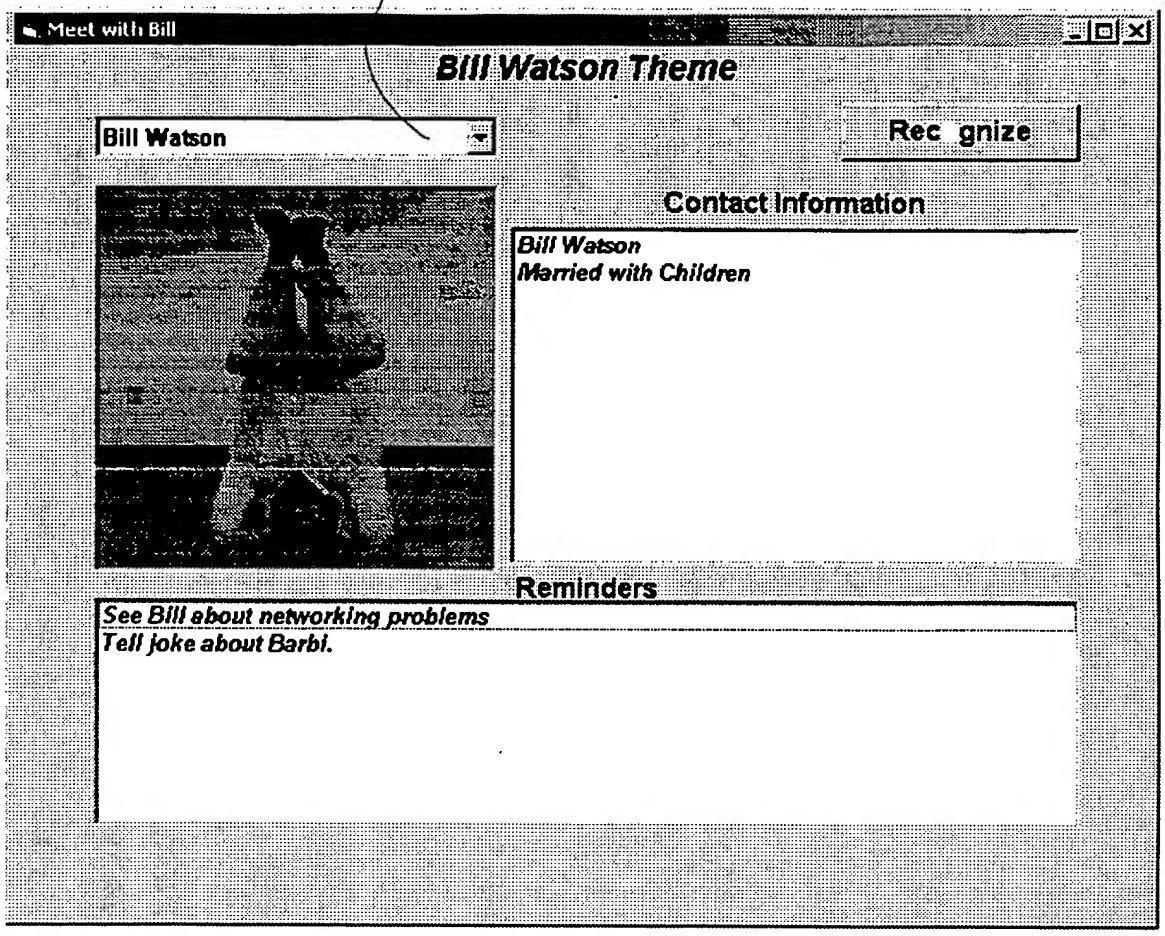

1135
Meet with Bill
Bill Watson Theme
Bill Watson
Rec gnize
Contact Information
Bill Watson
Married with Children
Reminders
See Bill about networking problems
Tell joke about Barbi.

Fig. 11E

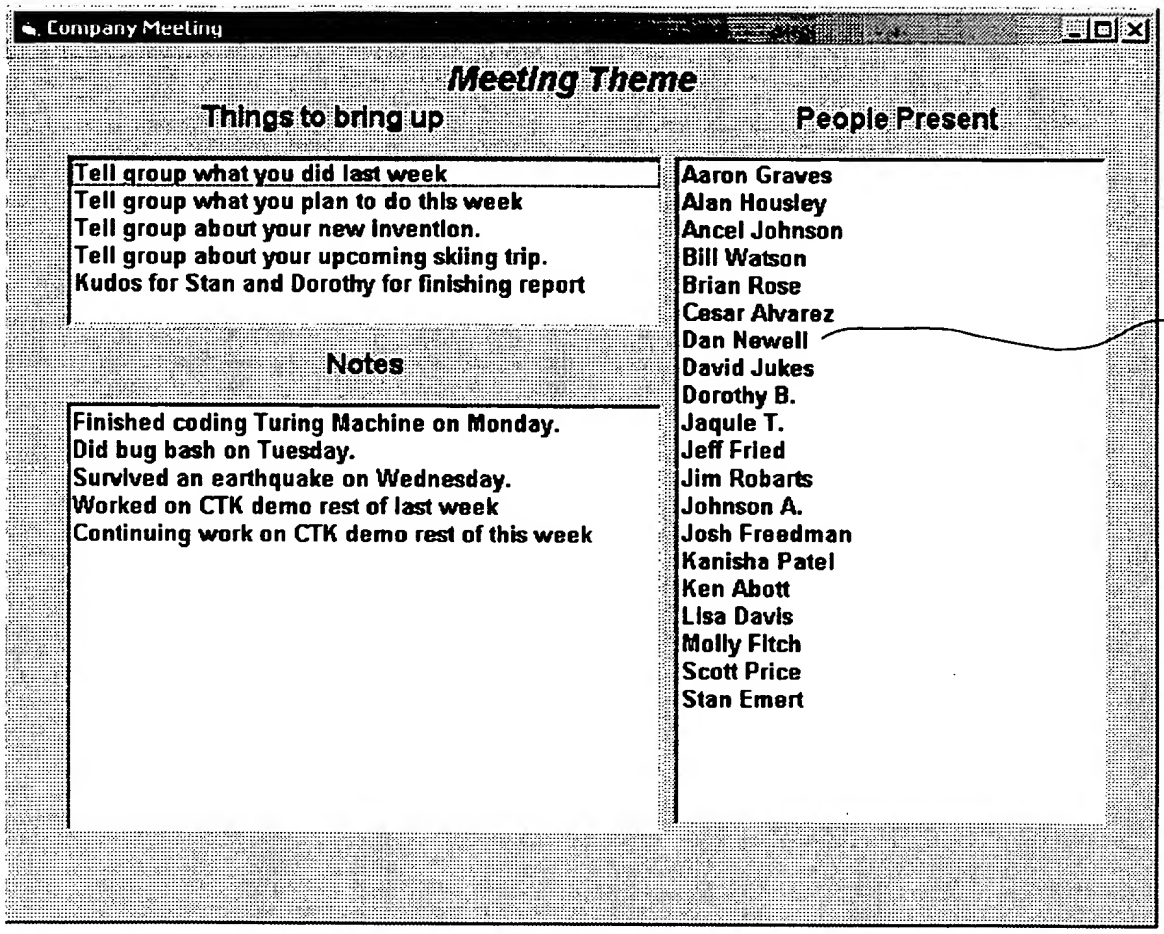

Company Meeting
Meeting Theme
Things to bring up
People Present
Tell group what you did last week
Tell group what you plan to do this week
Tell group about your new invention.
Tell group about your upcoming skiing trip.
Kudos for Stan and Dorothy for finishing report
Aaron Graves
Alan Housley
Ancel Johnson
Bill Watson
Brian Rose
Cesar Alvarez
Dan Newell
David Jukes
Dorothy B.
Jaqule T.
Jeff Fried
Jim Robarts
Johnson A.
Josh Freedman
Kanisha Patel
Ken Abott
Lisa Davis
Molly Fitch
Scott Price
Stan Emert
Notes
Finished coding Turing Machine on Monday.
Did bug bash on Tuesday.
Survived an earthquake on Wednesday.
Worked on CTK demo rest of last week
Continuing work on CTK demo rest of this week
1137

Fig. 11F

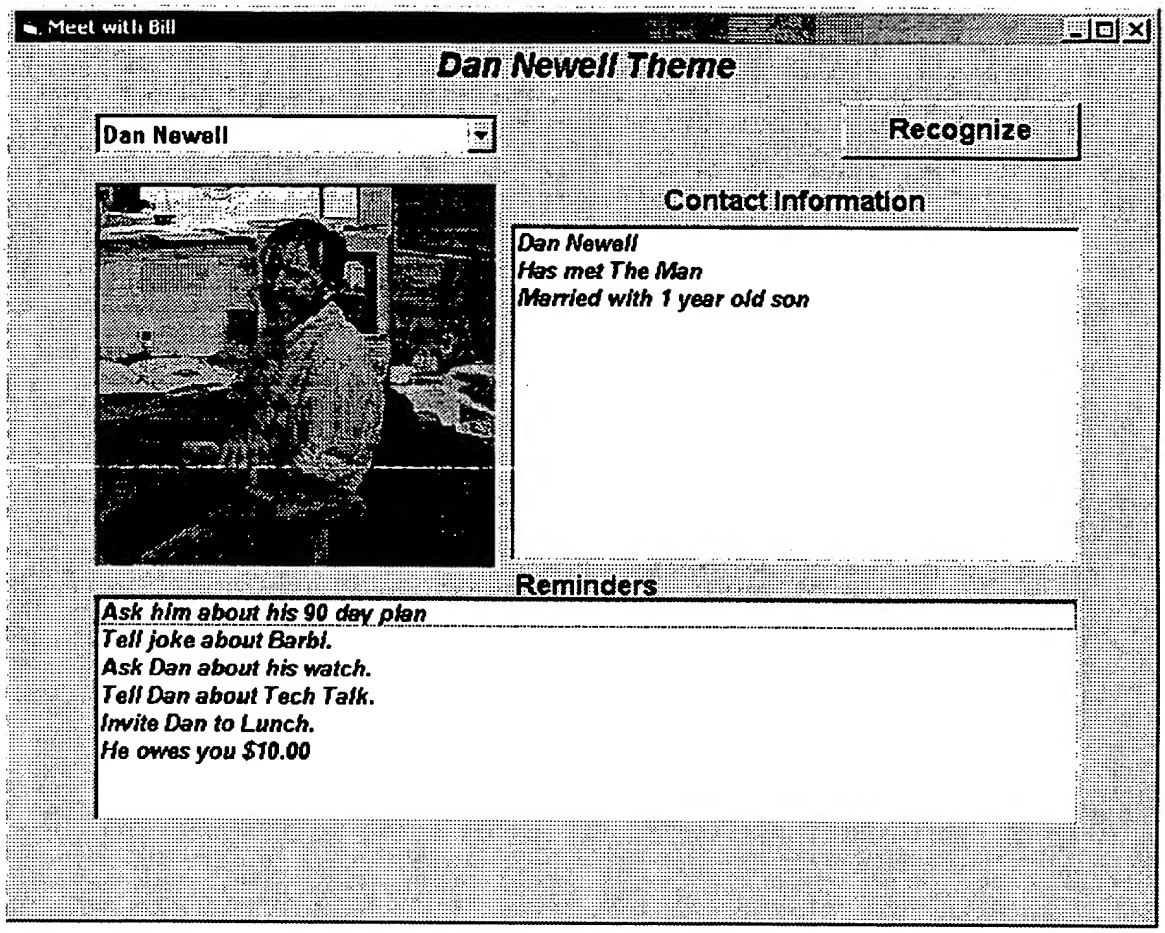

Meet with Bill
Dan Newell Theme
Dan Newell
Recognize
Contact Information
Dan Newell
Has met The Man
Married with 1 year old son
Reminders
Ask him about his 90 day plan
Tell joke about Barbi.
Ask Dan about his watch.
Tell Dan about Tech Talk.
Invite Dan to Lunch.
He owes you $10.00

Fig. 11G

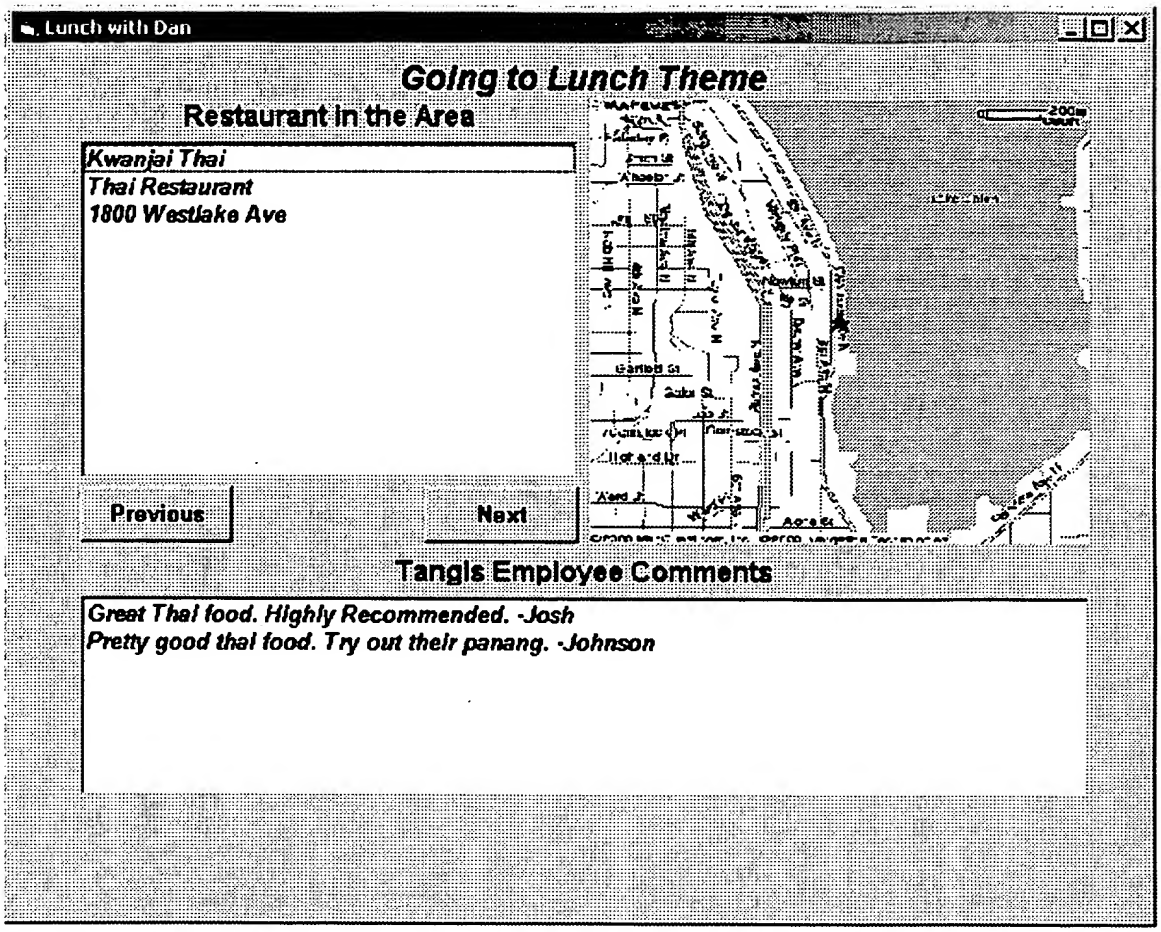

Lunch with Dan
Going to Lunch Theme
Restaurant in the Area
Kwanjai Thai
Thai Restaurant
1800 Westlake Ave
Previous
Next
Tangis Employee Comments
Great Thai food. Highly Recommended. -Josh
Pretty good thai food. Try out their panang. -Johnson

Fig. 11H

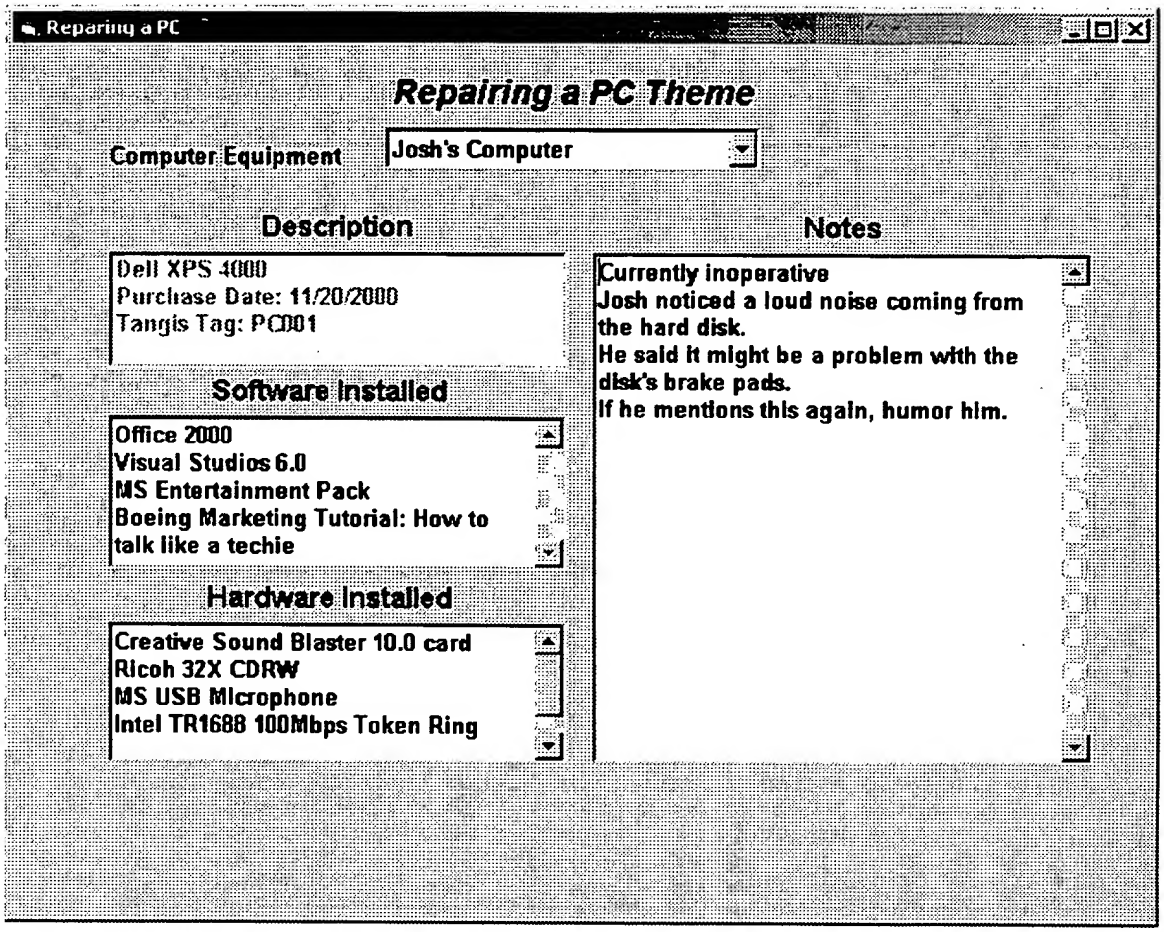
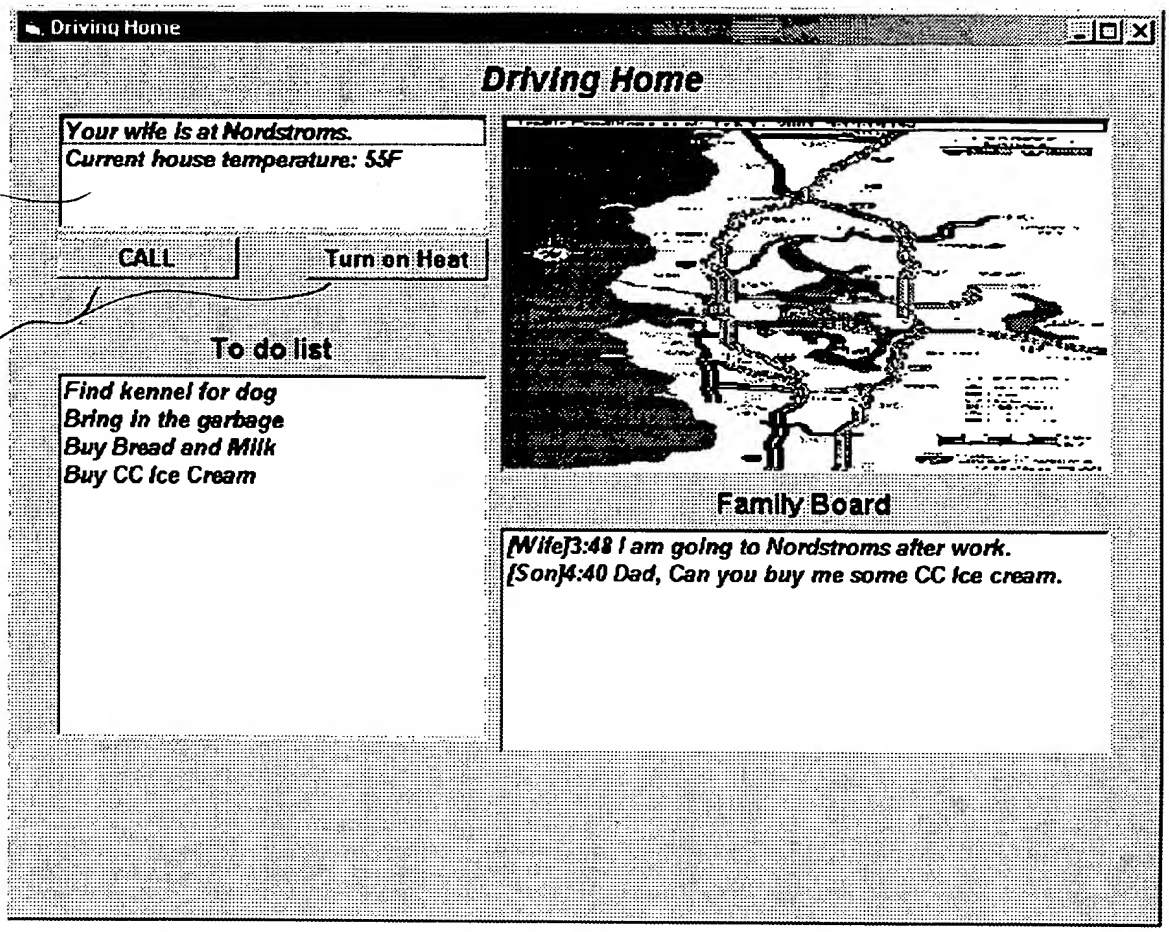

Repairing a PC
Repairing a PC Theme
Computer Equipment
Josh's Computer
Description
Dell XPS 4000
Purchase Date: 11/20/2000
Tangis Tag: PC001
Software Installed
Office 2000
Visual Studios 6.0
MS Entertainment Pack
Boeing Marketing Tutorial: How to talk like a techie
Hardware Installed
Creative Sound Blaster 10.0 card
Ricoh 32X CDRW
MS USB Microphone
Intel TR1688 100Mbps Token Ring
Notes
Currently inoperative
Josh noticed a loud noise coming from the hard disk.
He said it might be a problem with the disk's brake pads.
If he mentions this again, humor him.

Fig. 11I




1140

1145

Fig. 11J

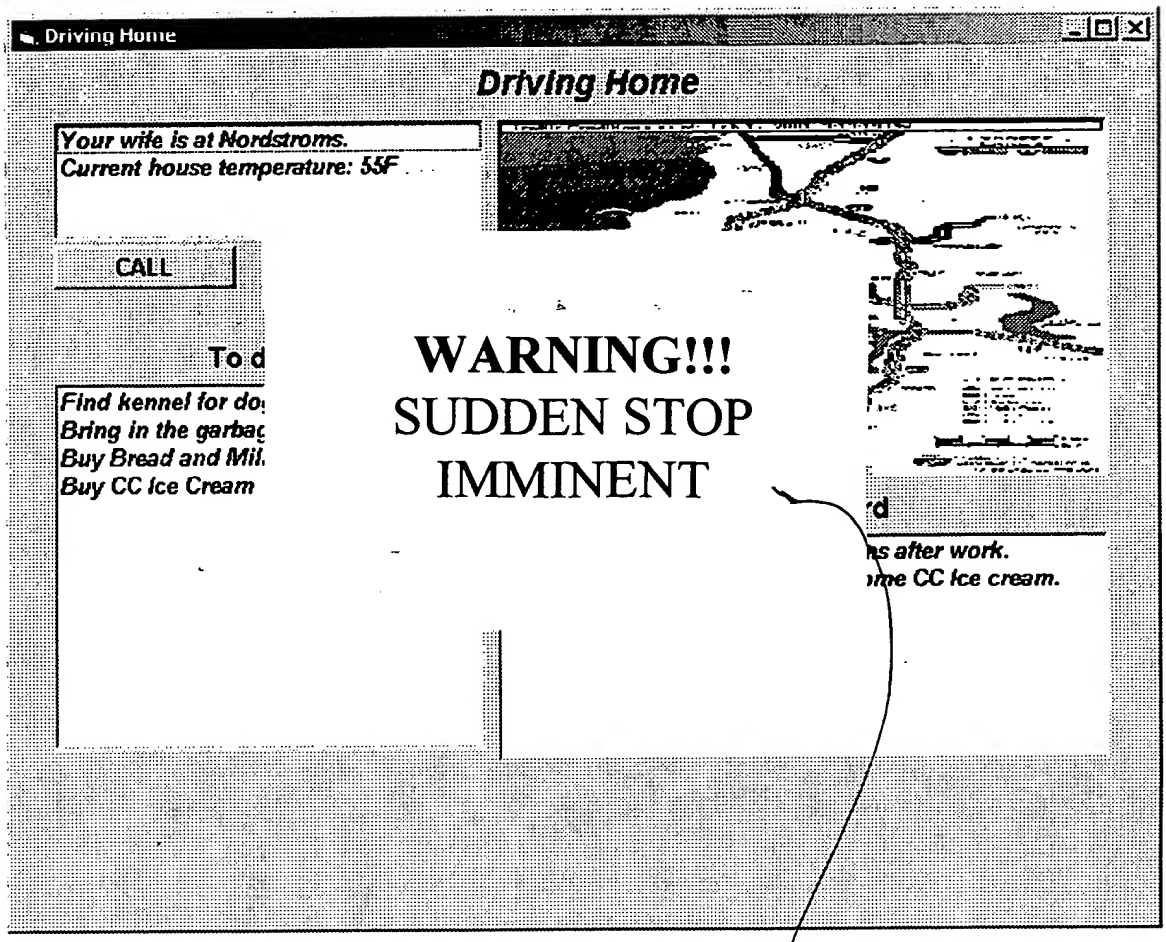

Driving Home
Driving Home
Your wife is at Nordstroms.
Current house temperature: 55F
CALL
To d
Find kennel for do
Bring in the garbag
Buy Bread and Mil
Buy CC Ice Cream
WARNING!!!
SUDDEN STOP
IMMINENT
d
s after work.
me CC Ice cream.

Fig. 11K

1190

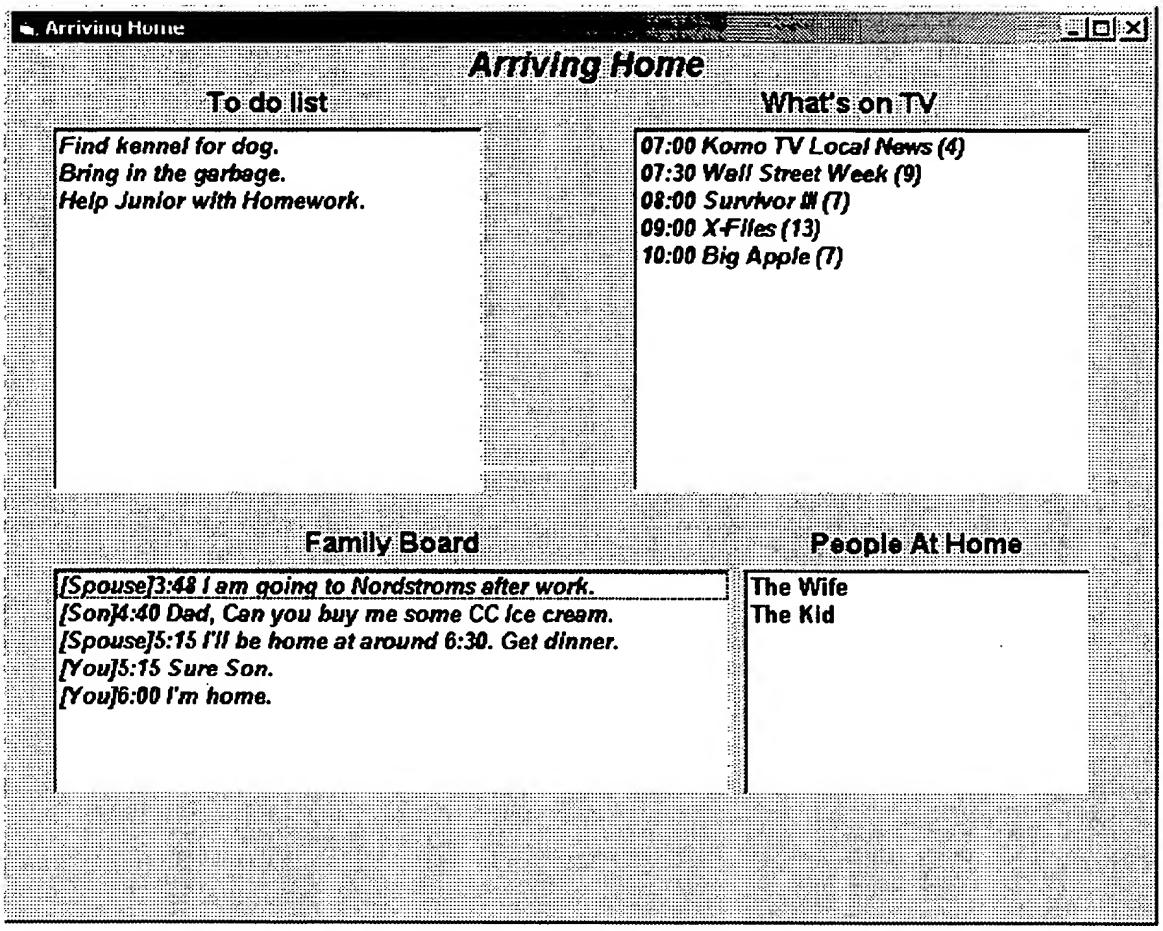

Arriving Home
Arriving Home
To do list
Find kennel for dog.
Bring in the garbage.
Help Junior with Homework.
What's on TV
07:00 Komo TV Local News (4)
07:30 Wall Street Week (9)
08:00 Survivor III (7)
09:00 X-Files (13)
10:00 Big Apple (7)
Family Board
[Spouse]3:48 I am going to Nordstroms after work.
[Son]4:40 Dad, Can you buy me some CC Ice cream.
[Spouse]5:15 I'll be home at around 6:30. Get dinner.
[You]5:15 Sure Son.
[You]6:00 I'm home.
People At Home
The Wife
The Kid

Fig. 11L

Example Current Theme Selection

***Select A New Current Theme***

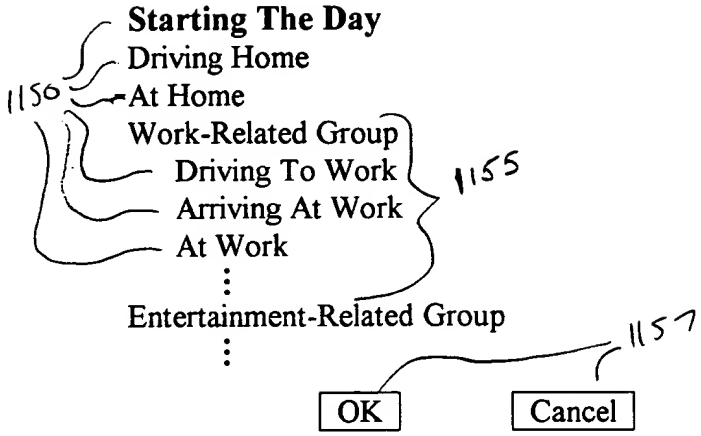



***Figure 11M***

Example Current Theme Set Modification

***Current Theme Set***

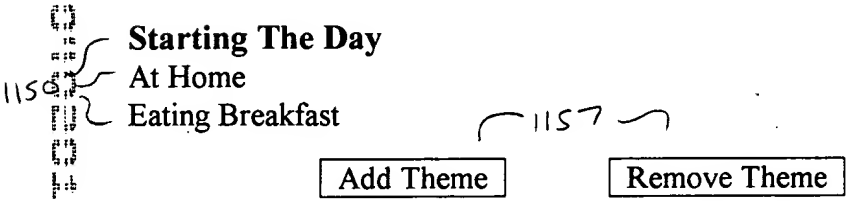



***Figure 11N***

Example Current Theme Layout Selection

***Select A New Current Theme Layout***

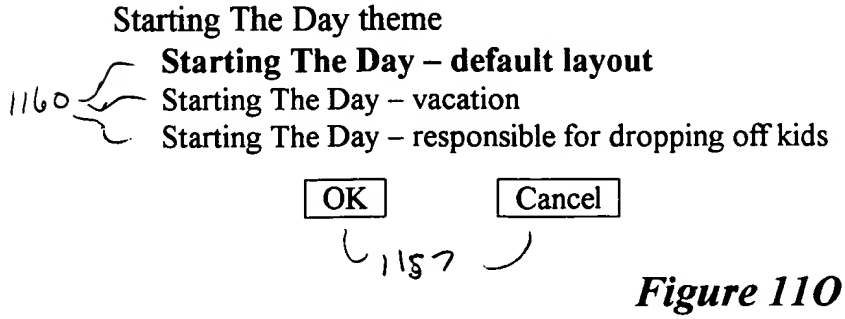



***Figure 11O***

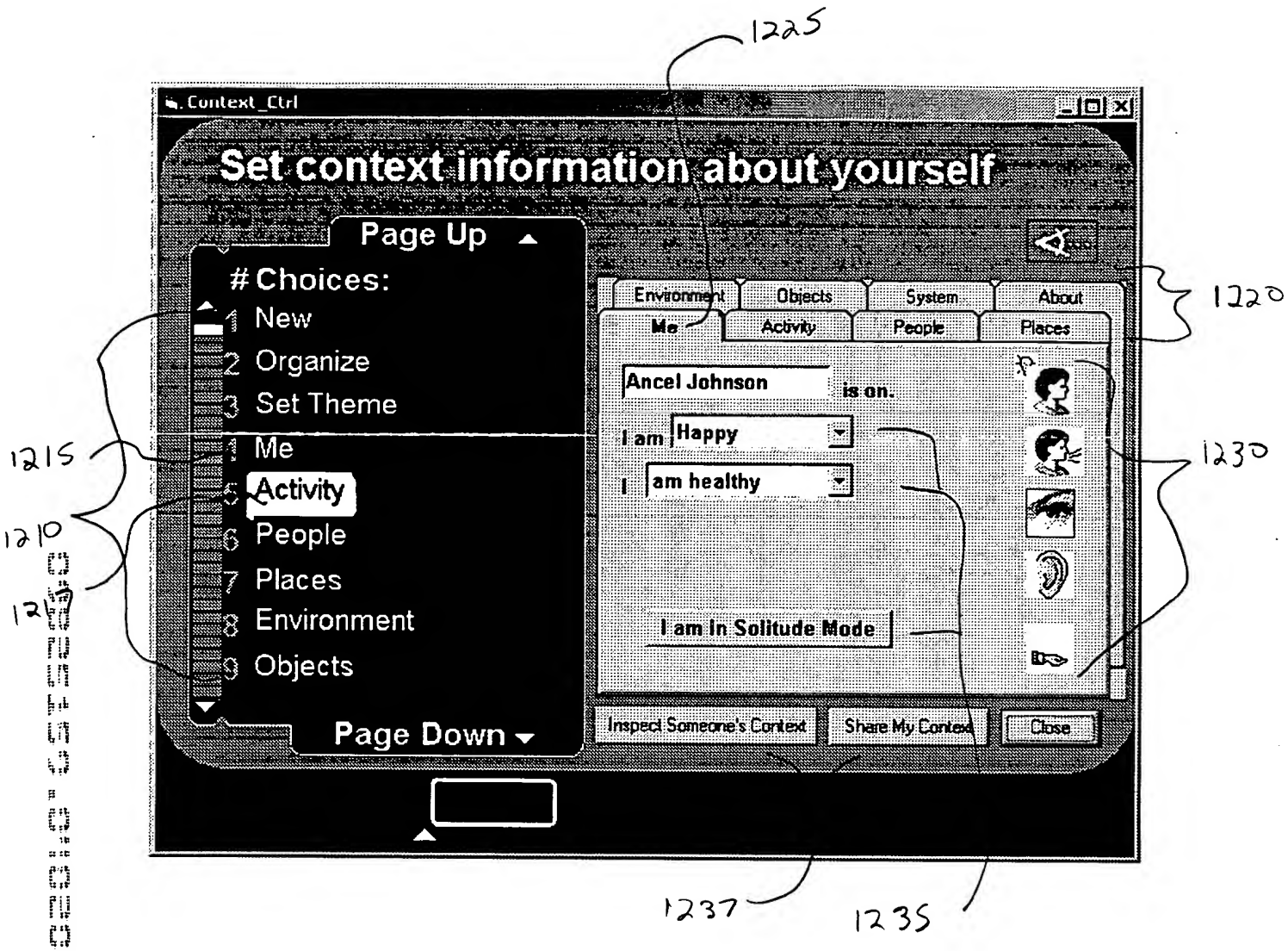

1225
Context_Ctrl
Set context information about yourself
Page Up
# Choices:
1 New
2 Organize
3 Set Theme
4 Me
5 Activity
6 People
7 Places
8 Environment
9 Objects
Page Down
Environment
Objects
System
About
Me
Activity
People
Places
Ancel Johnson
is on.
I am
Happy
I
am healthy
I am In Solitude Mode
Inspect Someone's Context
Share My Context
Close
1220
1215
1210
1230
1237
1235

Fig. 12A

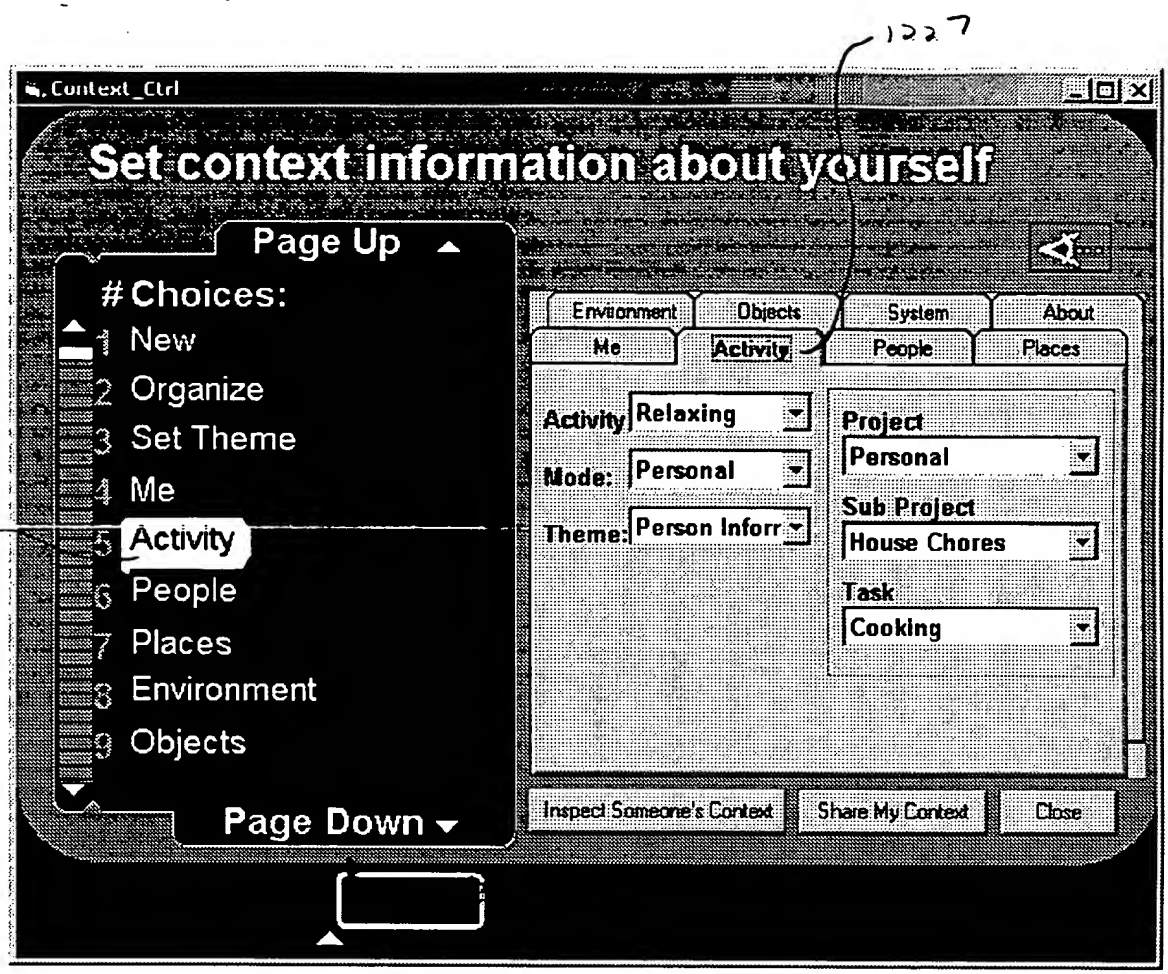

1227
Context_Ctrl
Set context information about yourself
Page Up
# Choices:
1 New
2 Organize
3 Set Theme
4 Me
5 Activity
6 People
7 Places
8 Environment
9 Objects
Page Down
1217
Environment
Objects
System
About
Me
Activity
People
Places
Activity: Relaxing
Mode: Personal
Theme: Person Inforr
Project
Personal
Sub Project
House Chores
Task
Cooking
Inspect Someone's Context
Share My Context
Close

Fig. 12B

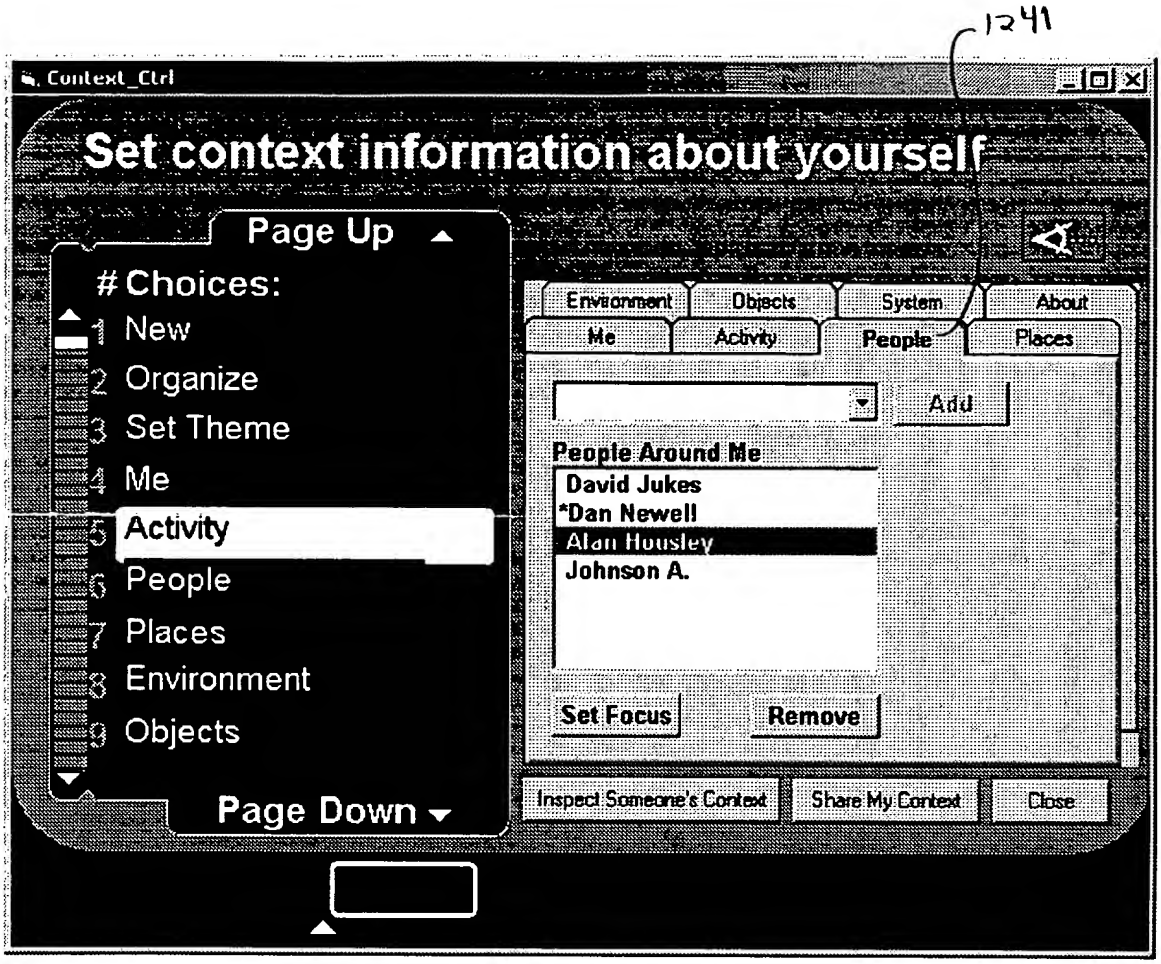

1241
Context_Ctrl
Set context information about yourself
Page Up
# Choices:
1 New
2 Organize
3 Set Theme
4 Me
5 Activity
6 People
7 Places
8 Environment
9 Objects
Page Down
Environment
Objects
System
About
Me
Activity
People
Places
Add
People Around Me
David Jukes
*Dan Newell
Alan Housley
Johnson A.
Set Focus
Remove
Inspect Someone's Context
Share My Context
Close

Fig. 12C

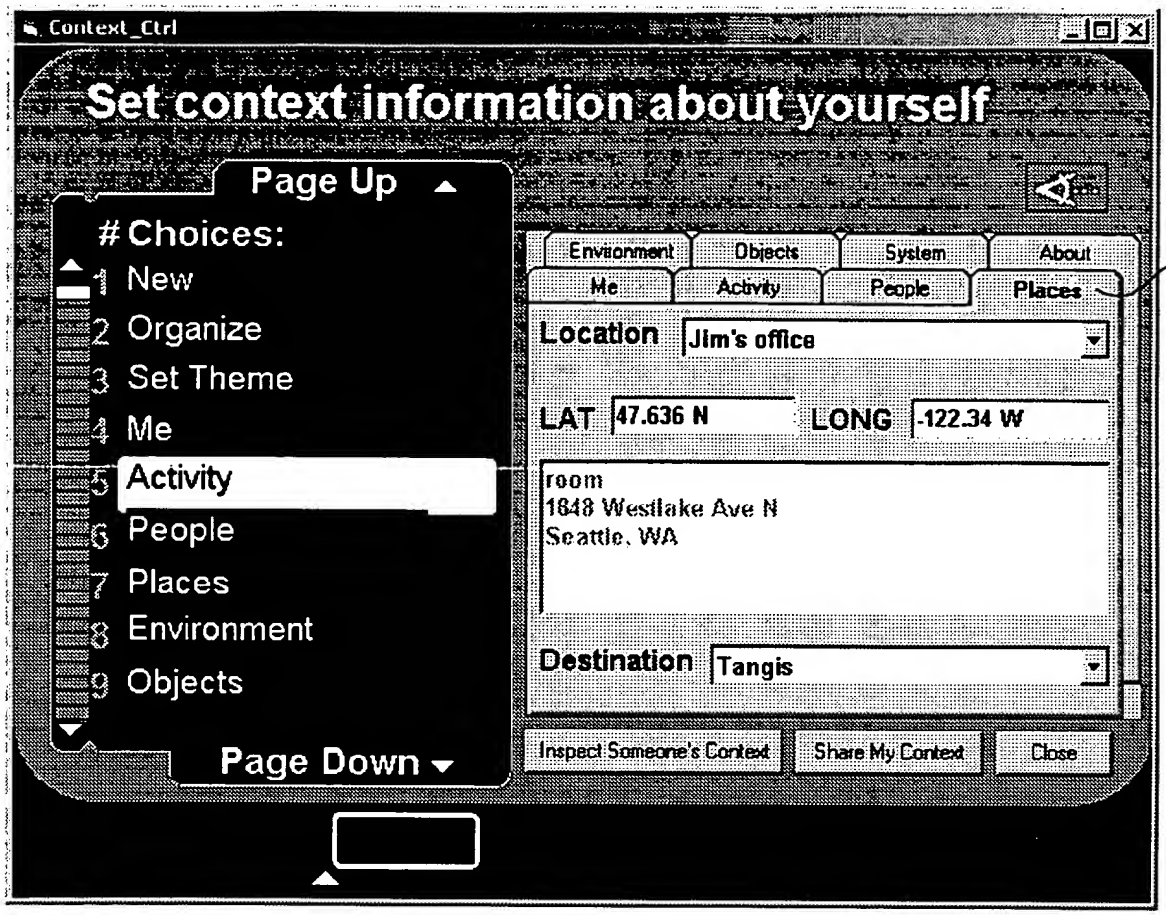

Context_Ctrl
Set context information about yourself
Page Up
# Choices:
1 New
2 Organize
3 Set Theme
4 Me
5 Activity
6 People
7 Places
8 Environment
9 Objects
Page Down
Environment
Objects
System
About
Me
Activity
People
Places
1242
Location
Jim's office
LAT
47.636 N
LONG
-122.34 W
room
1648 Westlake Ave N
Seattle, WA
Destination
Tangis
Inspect Someone's Context
Share My Context
Close

Fig. 12D

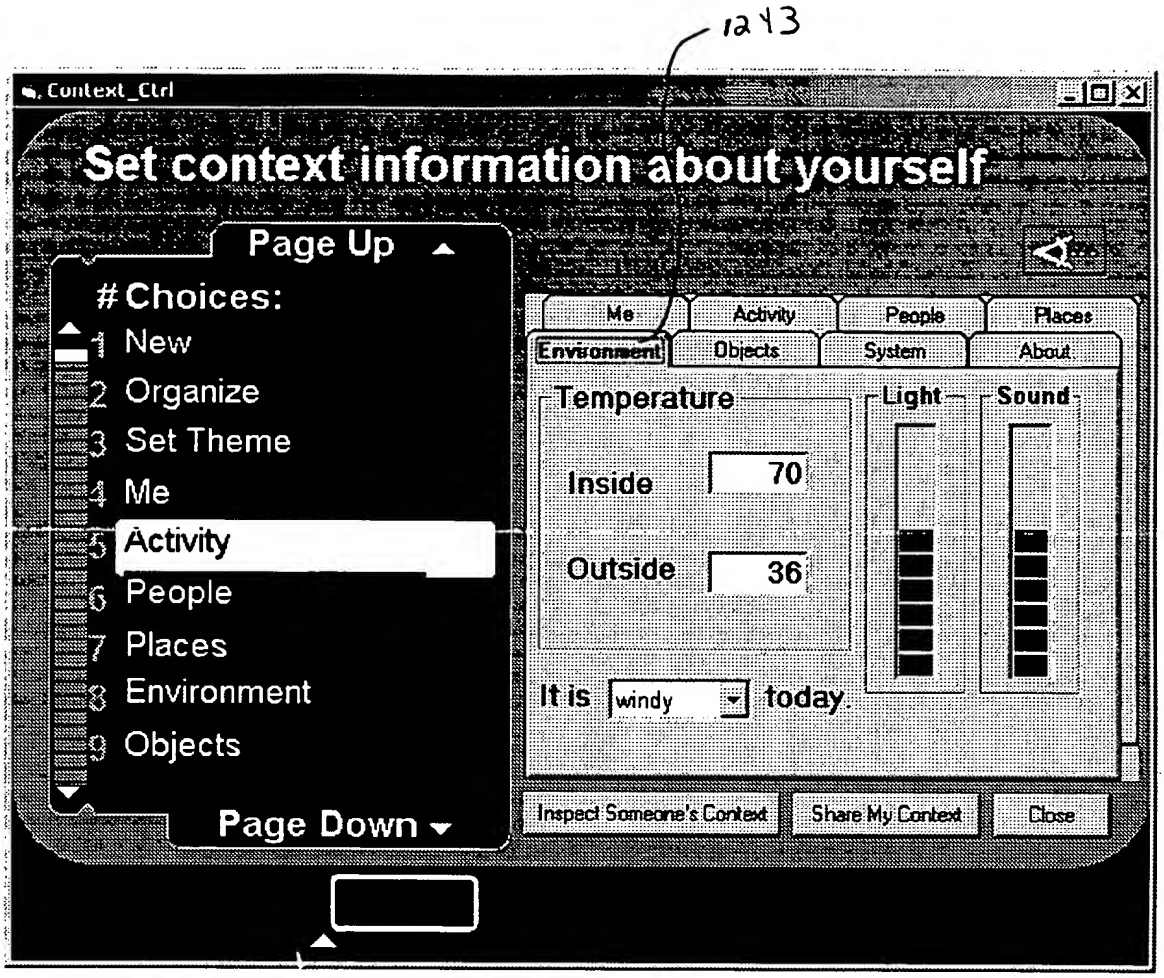

1243
Context_Ctrl
Set context information about yourself
Page Up
# Choices:
1 New
2 Organize
3 Set Theme
4 Me
5 Activity
6 People
7 Places
8 Environment
9 Objects
Page Down
Me
Activity
People
Places
Environment
Objects
System
About
Temperature
Inside
70
Outside
36
Light
Sound
It is
windy
today
Inspect Someone's Context
Share My Context
Close

Fig. 12E

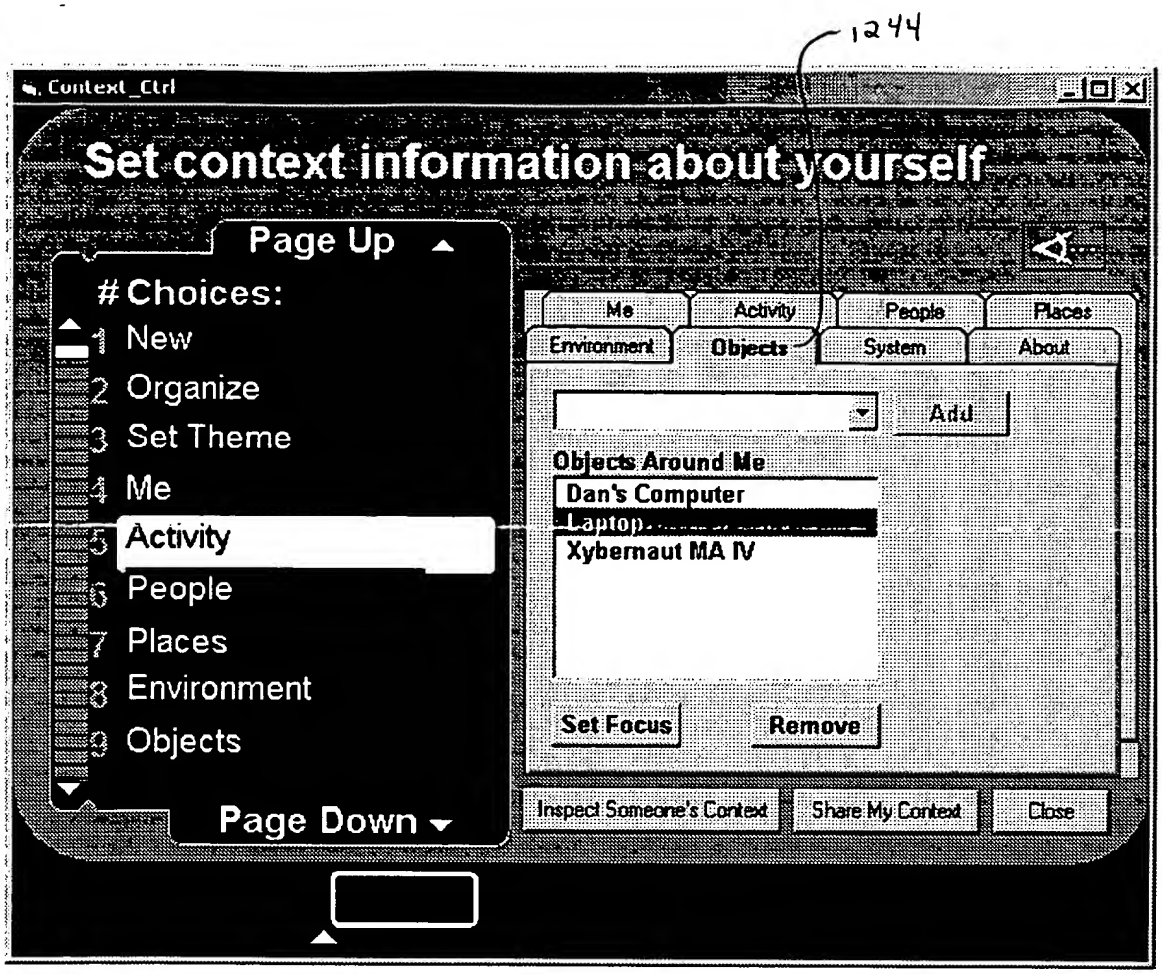

1244
Context_Ctrl
Set context information about yourself
Page Up
# Choices:
1 New
2 Organize
3 Set Theme
4 Me
5 Activity
6 People
7 Places
8 Environment
9 Objects
Page Down
Me
Activity
People
Places
Environment
Objects
System
About
Add
Objects Around Me
Dan's Computer
Laptop
Xybernaut MA IV
Set Focus
Remove
Inspect Someone's Context
Share My Context
Close

Fig. 12F

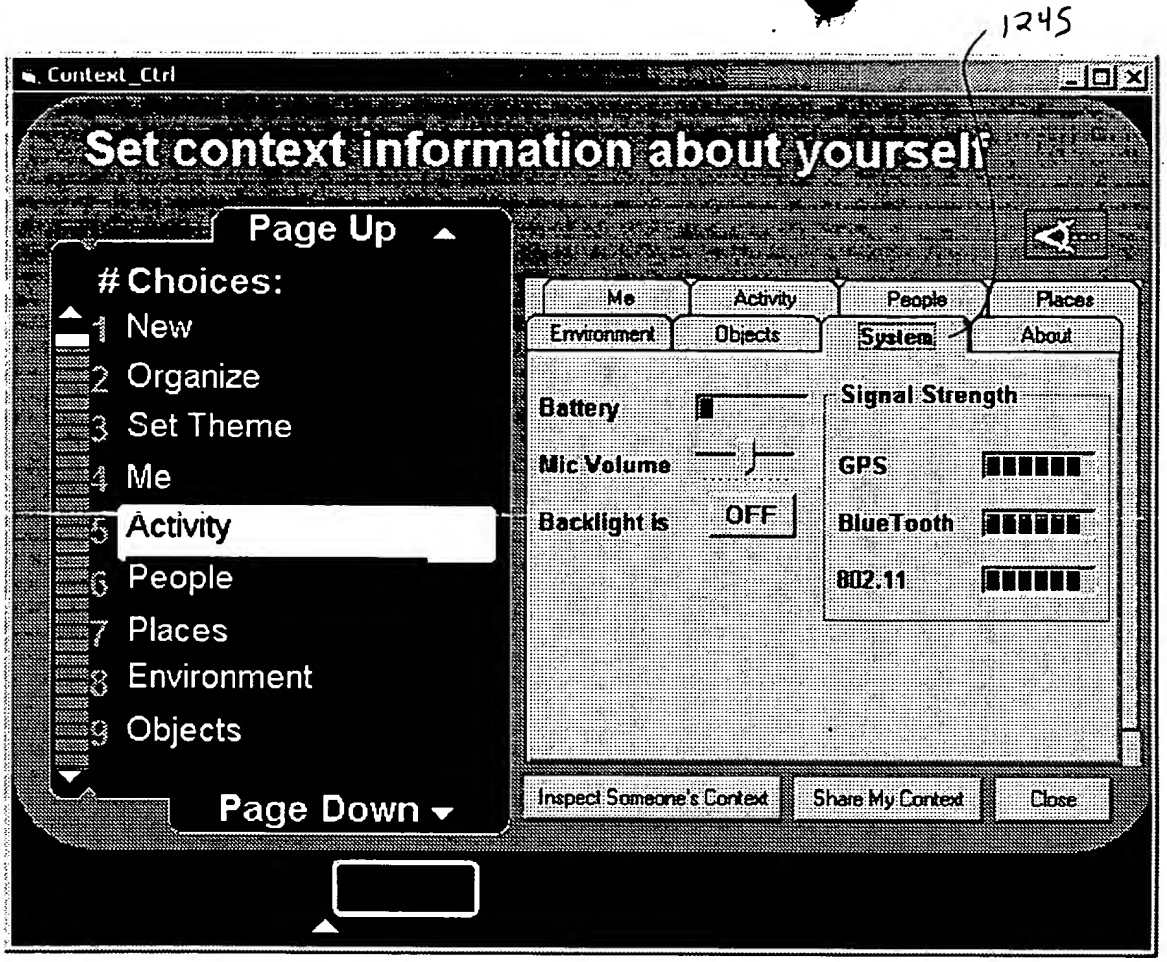

1245
Context_Ctrl
Set context information about yourself
Page Up
# Choices:
1 New
2 Organize
3 Set Theme
4 Me
5 Activity
6 People
7 Places
8 Environment
9 Objects
Page Down
Me
Activity
People
Places
Environment
Objects
System
About
Battery
Mic Volume
Backlight is
OFF
Signal Strength
GPS
BlueTooth
802.11
Inspect Someone's Context
Share My Context
Close

Fig. 12G

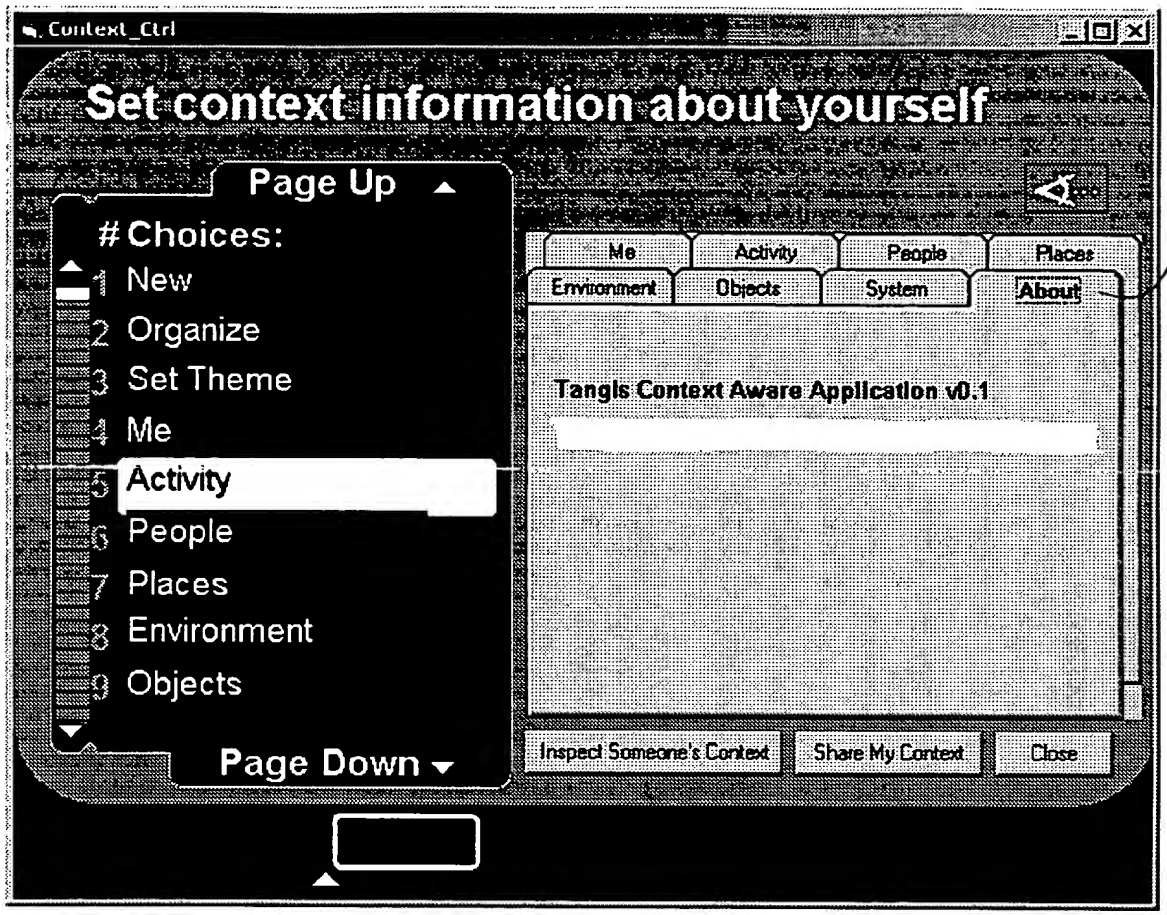

Context_Ctrl
Set context information about yourself
Page Up
# Choices:
1 New
2 Organize
3 Set Theme
4 Me
5 Activity
6 People
7 Places
8 Environment
9 Objects
Page Down
Me
Activity
People
Places
Environment
Objects
System
About
1246
Tangis Context Aware Application v0.1
Inspect Someone's Context
Share My Context
Close

Fig. 12H

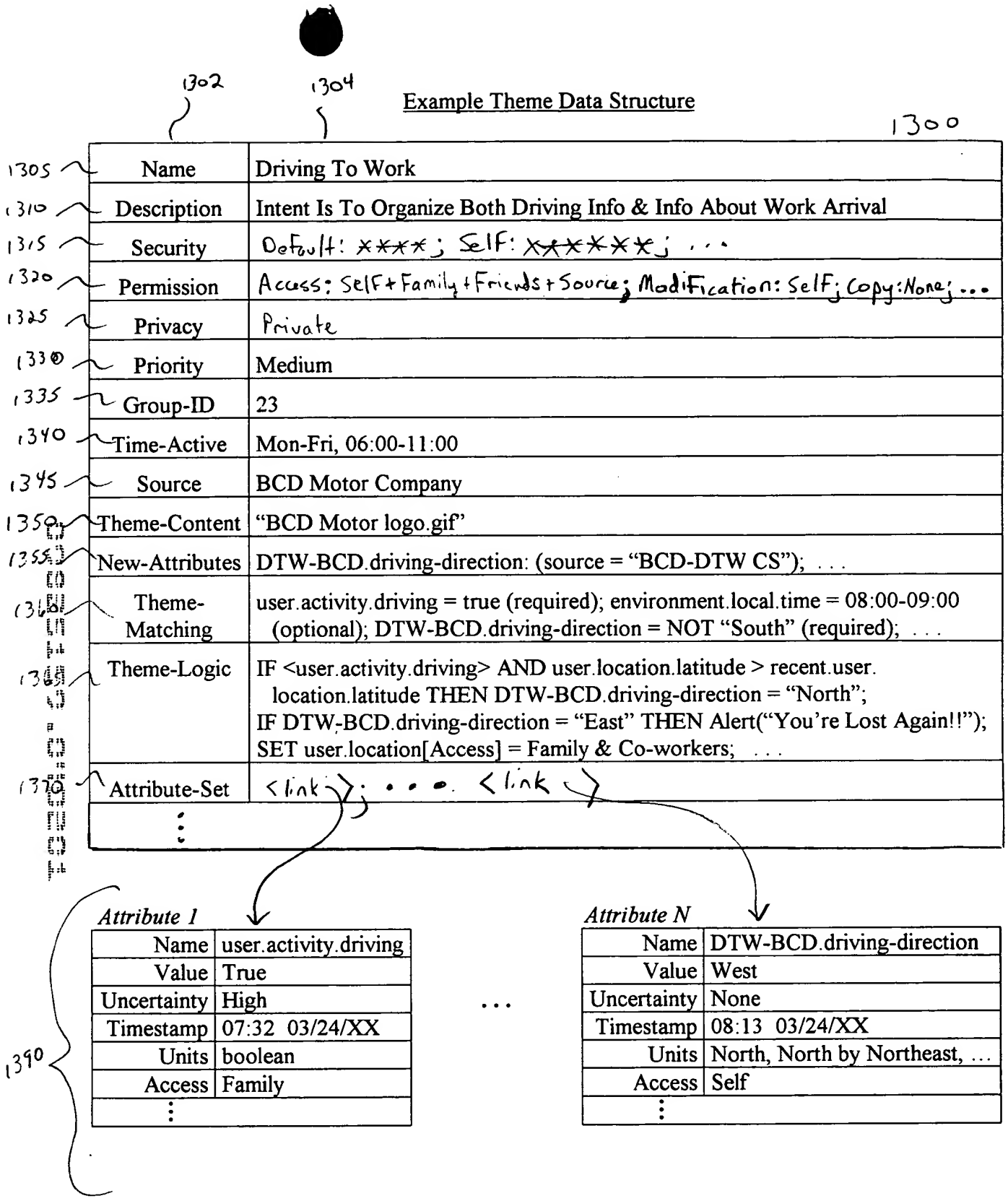

1302
1304
Example Theme Data Structure
1300
1305
Name
Driving To Work
1310
Description
Intent Is To Organize Both Driving Info & Info About Work Arrival
1315
Security
Default: ****; Self: *******; ...
1320
Permission
Access: Self+Family+Friends+Source; Modification: Self; Copy:None; ...
1325
Privacy
Private
1330
Priority
Medium
1335
Group-ID
23
1340
Time-Active
Mon-Fri, 06:00-11:00
1345
Source
BCD Motor Company
1350
Theme-Content
"BCD Motor logo.gif"
1355
New-Attributes
DTW-BCD.driving-direction: (source = "BCD-DTW CS"); . . .
1360
Theme-Matching
user.activity.driving = true (required); environment.local.time = 08:00-09:00 (optional); DTW-BCD.driving-direction = NOT "South" (required); . . .
1365
Theme-Logic
IF <user.activity.driving> AND user.location.latitude > recent.user.location.latitude THEN DTW-BCD.driving-direction = "North";
IF DTW-BCD.driving-direction = "East" THEN Alert("You're Lost Again!!");
SET user.location[Access] = Family & Co-workers; . . .
1370
Attribute-Set
<link>; . . . <link>
Attribute 1
Name
user.activity.driving
Value
True
Uncertainty
High
Timestamp
07:32 03/24/XX
Units
boolean
Access
Family
1390
Attribute N
Name
DTW-BCD.driving-direction
Value
West
Uncertainty
None
Timestamp
08:13 03/24/XX
Units
North, North by Northeast, ...
Access
Self

***Figure 13***

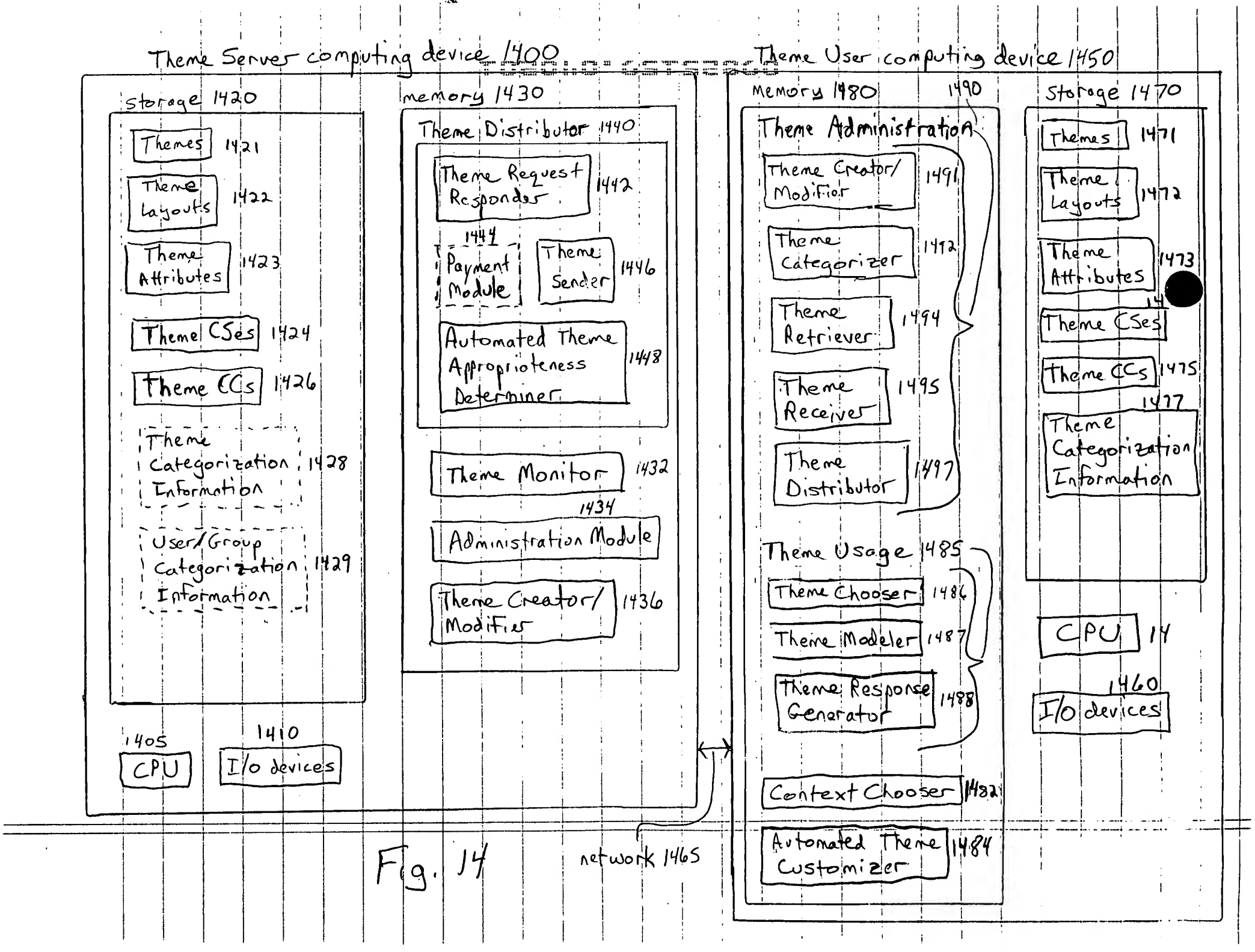

Theme Server computing device 1400
storage 1420
Themes 1421
Theme Layouts 1422
Theme Attributes 1423
Theme CSes 1424
Theme CCs 1426
Theme Categorization Information 1428
User/Group Categorization Information 1429
CPU 1405
I/O devices 1410
memory 1430
Theme Distributor 1440
Theme Request Responder 1442
Payment Module 1444
Theme Sender 1446
Automated Theme Appropriateness Determiner 1448
Theme Monitor 1432
Administration Module 1434
Theme Creator/Modifier 1436
network 1465
Theme User computing device 1450
Memory 1480
Theme Administration 1490
Theme Creator/Modifier 1491
Theme Categorizer 1492
Theme Retriever 1494
Theme Receiver 1495
Theme Distributor 1497
Theme Usage 1485
Theme Chooser 1486
Theme Modeler 1487
Theme Response Generator 1488
Context Chooser 1482
Automated Theme Customizer 1484
Storage 1470
Themes 1471
Theme Layouts 1472
Theme Attributes 1473
Theme CSes 14
Theme CCs 1475
1477
Theme Categorization Information
CPU 14
1460
I/O devices

Fig. 14

Fig. 15

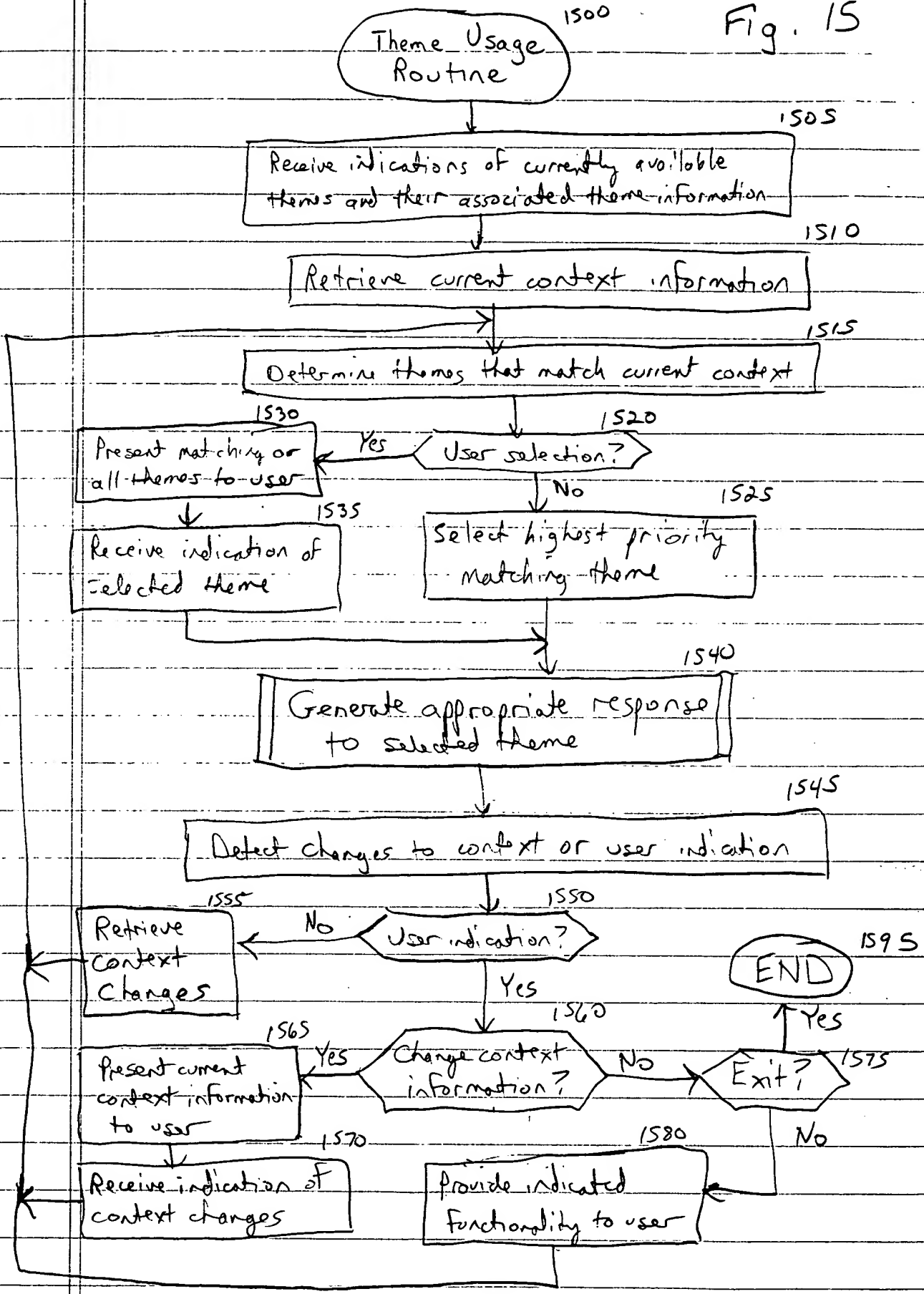

Theme Usage Routine
1500
Receive indications of currently available themes and their associated theme information
1505
Retrieve current context information
1510
Determine themes that match current context
1515
User selection?
1520
Yes
Present matching or all themes to user
1530
No
Select highest priority matching theme
1525
Receive indication of selected theme
1535
Generate appropriate response to selected theme
1540
Detect changes to context or user indication
1545
User indication?
1550
No
Retrieve context changes
1555
Yes
Change context information?
1560
No
Exit?
1575
Yes
END
1595
Present current context information to user
1565
Yes
Receive indication of context changes
1570
Provide indicated functionality to user
1580
No

Fig. 16

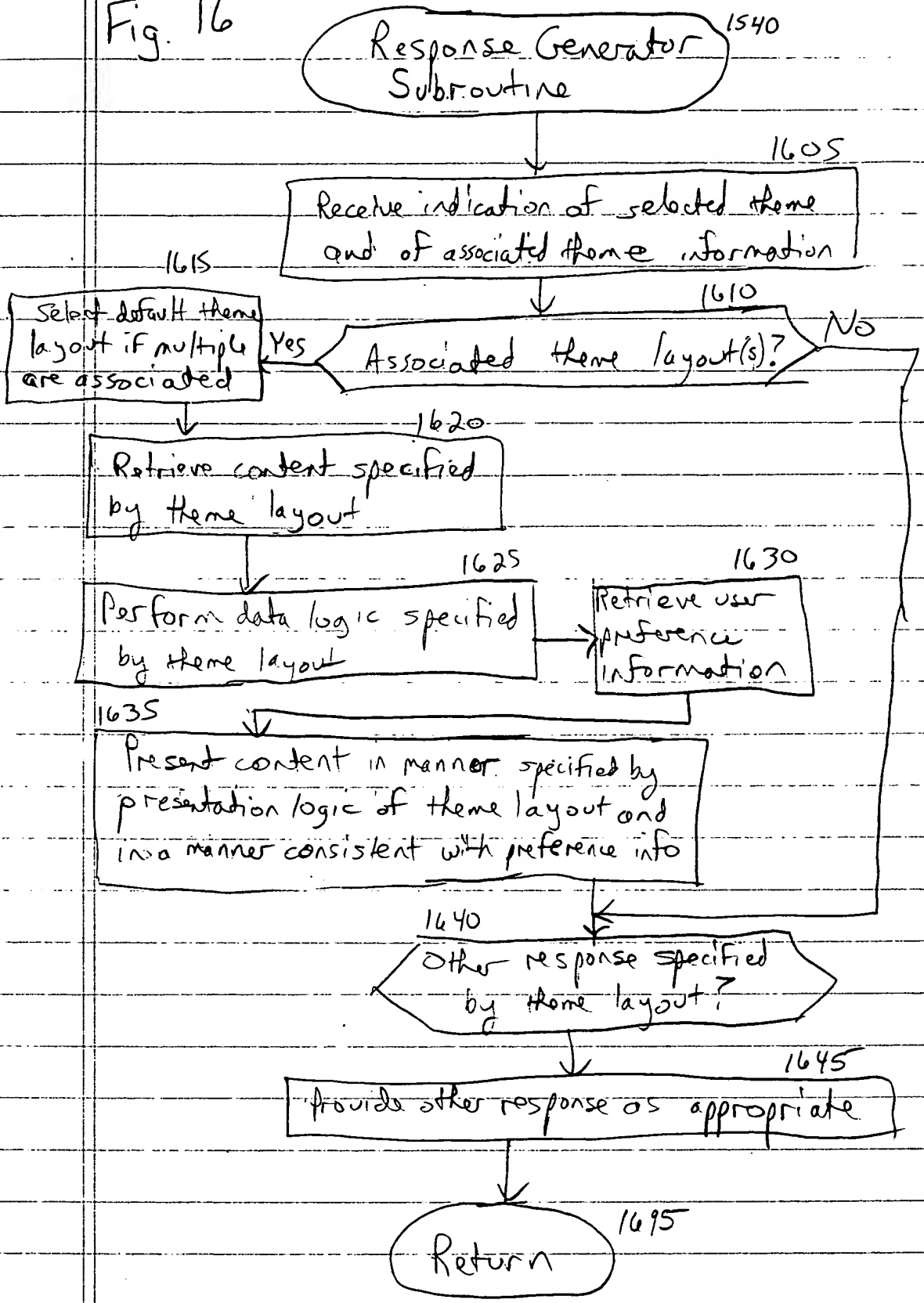

Response Generator Subroutine
1540
1605
Receive indication of selected theme and of associated theme information
1610
Associated theme layout(s)?
Yes
No
1615
Select default theme layout if multiple are associated
1620
Retrieve content specified by theme layout
1625
Perform data logic specified by theme layout
1630
Retrieve user preference information
1635
Present content in manner specified by presentation logic of theme layout and in a manner consistent with preference info
1640
Other response specified by theme layout?
1645
Provide other response as appropriate
1695
Return

Fig. 17

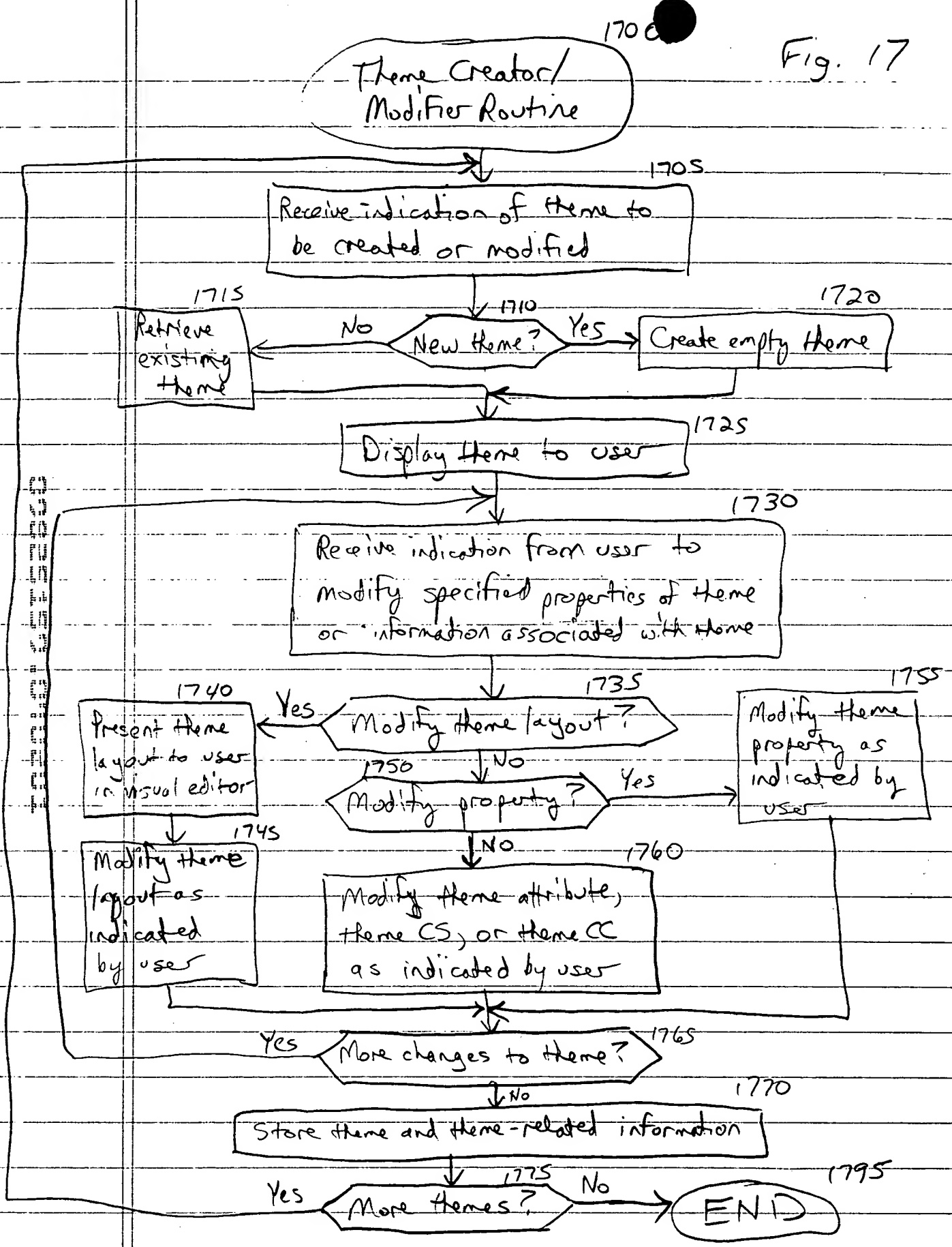

1700
Theme Creator/ Modifier Routine
1705
Receive indication of theme to be created or modified
1710
New theme?
No
Yes
1715
Retrieve existing theme
1720
Create empty theme
1725
Display theme to user
1730
Receive indication from user to modify specified properties of theme or information associated with theme
1735
Modify theme layout?
Yes
1740
Present theme layout to user in visual editor
1745
Modify theme layout as indicated by user
No
1750
Modify property?
Yes
1755
Modify theme property as indicated by user
No
1760
Modify theme attribute, theme CS, or theme CC as indicated by user
1765
More changes to theme?
Yes
No
1770
Store theme and theme-related information
1775
More themes?
Yes
No
1795
END

Fig. 18

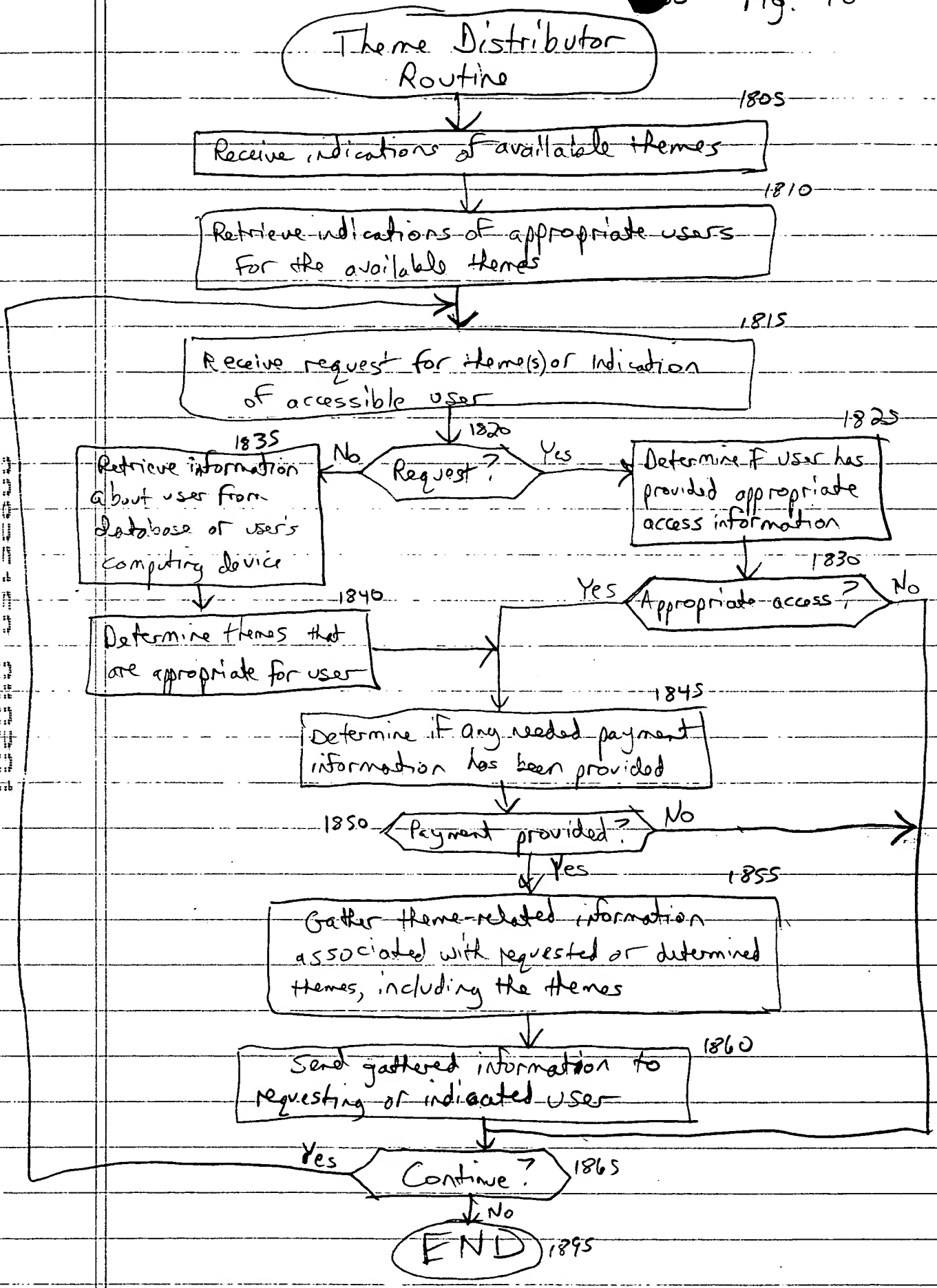

Theme Distributor Routine
1805
Receive indications of available themes
1810
Retrieve indications of appropriate users for the available themes
1815
Receive request for theme(s) or indication of accessible user
1820
Request?
No
Yes
1825
Determine if user has provided appropriate access information
1830
Appropriate access?
Yes
No
1835
Retrieve information about user from database or user's computing device
1840
Determine themes that are appropriate for user
1845
Determine if any needed payment information has been provided
1850
Payment provided?
No
Yes
1855
Gather theme-related information associated with requested or determined themes, including the themes
1860
Send gathered information to requesting or indicated user
Yes
Continue?
1865
No
END
1895

Fig. 19

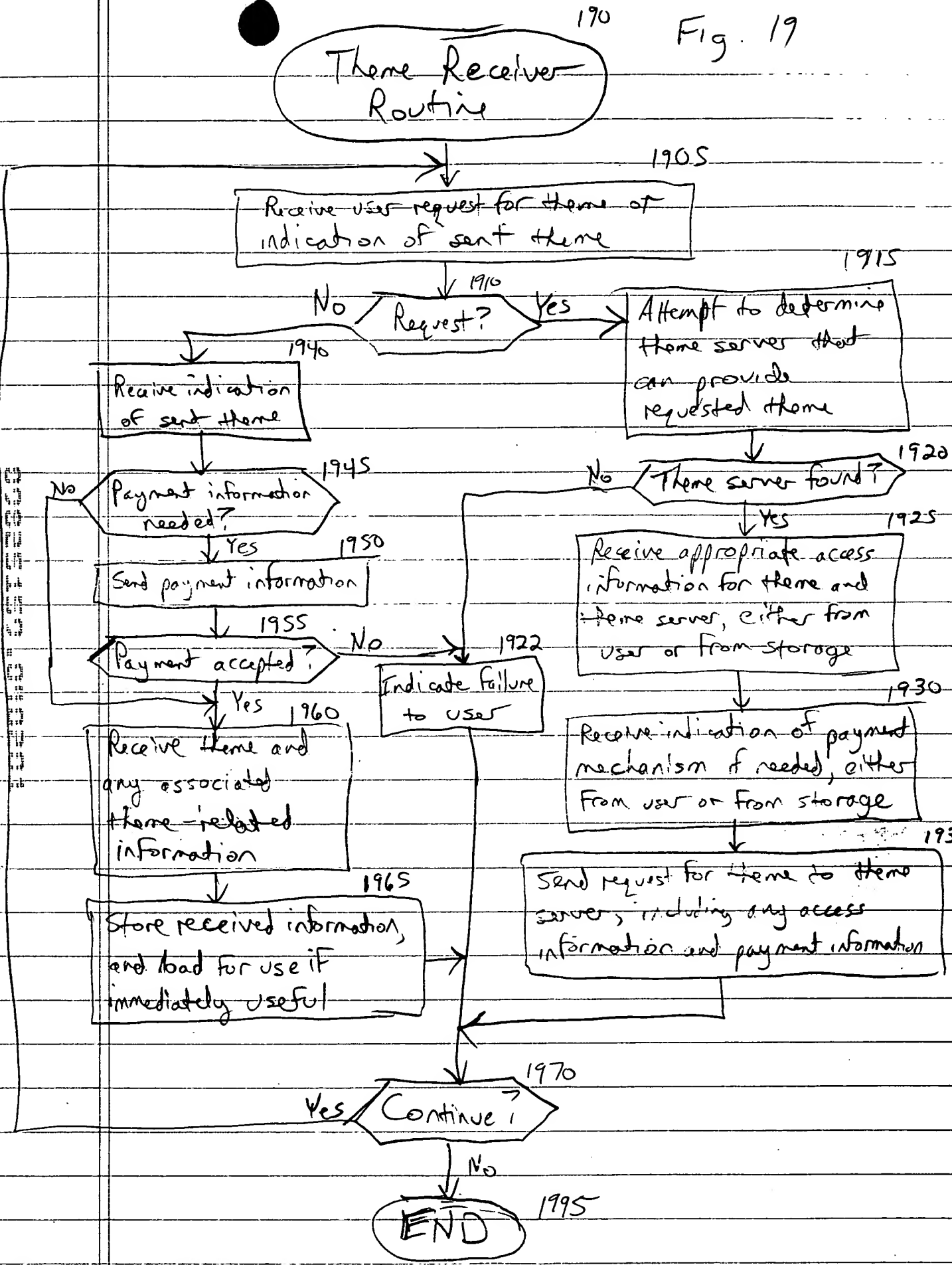
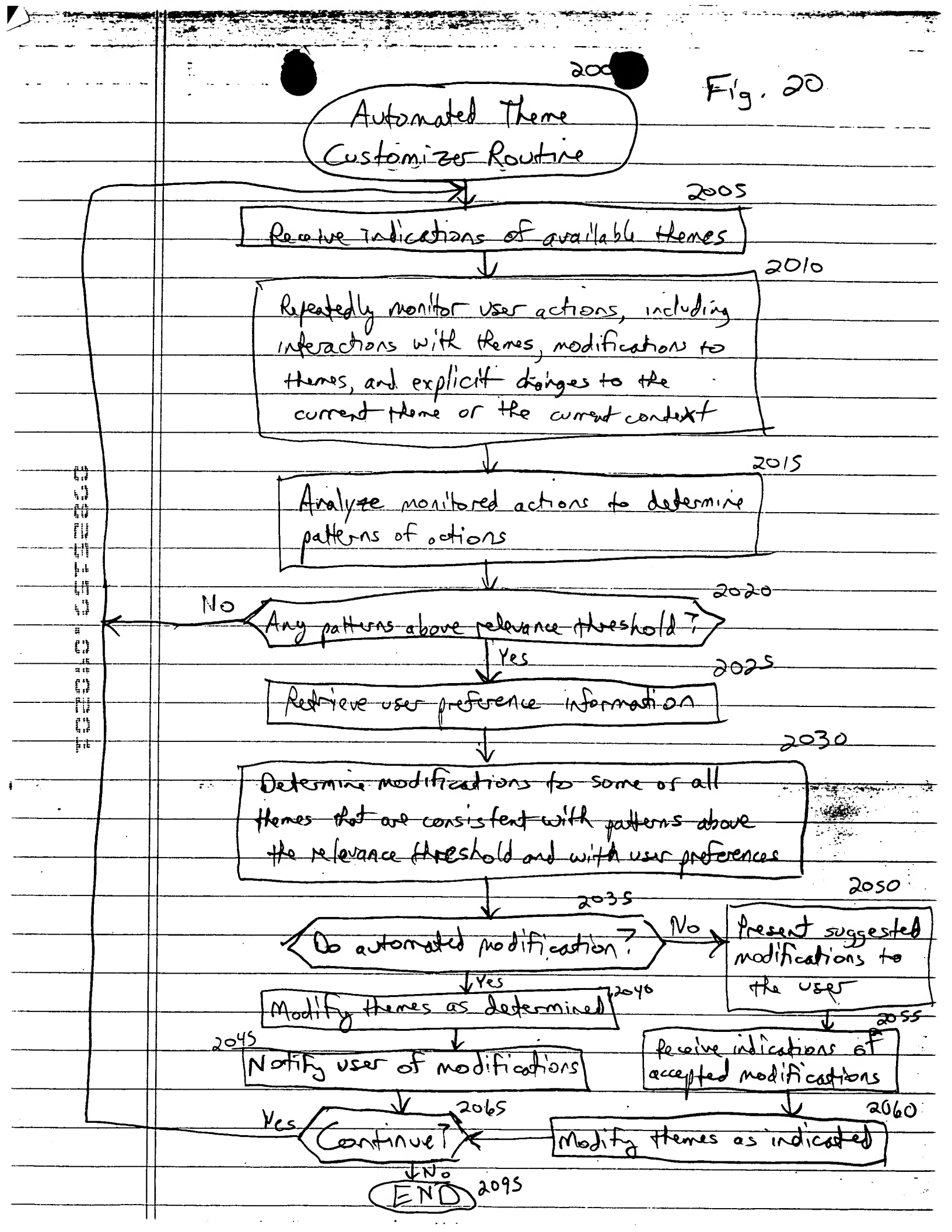

1900
Theme Receiver Routine
1905
Receive user request for theme or indication of sent theme
1910
Request?
No
Yes
1915
Attempt to determine theme server that can provide requested theme
1920
Theme server found?
No
Yes
1922
Indicate failure to user
1925
Receive appropriate access information for theme and theme server, either from user or from storage
1930
Receive indication of payment mechanism if needed, either from user or from storage
1935
Send request for theme to theme server, including any access information and payment information
1940
Receive indication of sent theme
1945
Payment information needed?
No
Yes
1950
Send payment information
1955
Payment accepted?
No
Yes
1960
Receive theme and any associated theme-related information
1965
Store received information, and load for use if immediately useful
1970
Continue?
Yes
No
1995
END

Fig. 20


200
Automated Theme Customizer Routine
2005
Receive indications of available themes
2010
Repeatedly monitor user actions, including interactions with themes, modifications to themes, and explicit changes to the current theme or the current context
2015
Analyze monitored actions to determine patterns of actions
2020
Any patterns above relevance threshold?
No
Yes
2025
Retrieve user preference information
2030
Determine modifications to some or all themes that are consistent with patterns above the relevance threshold and with user preferences
2035
Do automated modification?
No
Yes
2050
Present suggested modifications to the user
2040
Modify themes as determined
2045
Notify user of modifications
2055
Receive indications of accepted modifications
2060
Modify themes as indicated
2065
Continue?
Yes
No
END
2095